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CONTENTS

	Page
Safety and Health in Industry	493
Freud's "Interpretation of Dreams". By Sir Cyril Burt, F.B.A.	495
Antibiotics. By Dr. N. G. Heatley	496
Measurement and Application of Nuclear Moments. By Dr. B. H. Flowers	497
Colour Television. By G. R. Noakes	497
Dyestuffs Chemistry. By Dr. S. Coffey	498
A New Scheme of Qualitative Inorganic Analysis. By Prof. J. R. Partington, M.B.E.	498
New X-Ray Data on Coals. By L. Cartz, R. Diamond and P. B. Hirsch	500
Chromosomes, Genes and Macromolecular Systems. By Prof. Francis O. Schmitt	503
Obituaries :	
Prof. Émile Borel. By Prof. T. A. A. Broadbent	505
Dr. W. L. H. Duckworth. By Prof. J. D. Boyd	505
Prof. S. F. Nadel. By Prof. Raymond Firth, F.B.A.	506
News and Views	506
South African Council for Scientific and Industrial Research : Report for 1954	512
Technical Co-operation Scheme of the Colombo Plan	513
Man-power in the British Coal Industry	514
Social Problems of Industrial Democracy	515
Fibre Microscopy	515
Rheology of Proteins. By A. G. Ward	516
Some Recent Developments in Magnetism. By A. C. Lynch and J. Watkins	517
Daily Maps of the Sun. By P. A. Wayman	518
B.B.C. Engineering Monographs	519
The Meteorological Office : Annual Report for 1954–1955. By B. J. Mason	519
Phytoplankton of Lake Tanganyika. By Dr. Kathleen M. Drew	520
The Product of the Human Blood Group *A* and *B* Genes in Individuals belonging to Group *AB*. By Prof. W. T. J. Morgan, F.R.S., and Dr. Winifred M. Watkins	521
Letters to the Editors :	
New Series of Ganglion-blocking Agents.—Dr. D. W. Adamson, J. W. Billinghurst, A. F. Green and Dr. S. Locket	523
Effect of Cortisone on the Blood.—Prof. T. Nicol and D. L. J. Bilbey	524
Composition of Gangliosides from Human Brain.—Prof. Lars Svennerholm	524
Mode of Action of Isoniazid.—Prof. Adrien Albert	525
Formation of Iron-binding Compounds by Micro-organisms.—J. A. Garibaldi and Prof. J. B. Neilands	526
Amino-Acid Sequence in a Hypertensin.—Dr. D. F. Elliott and Dr. W. S. Peart	527
The Pigment, Trichosiderin, from Human Red Hair.—Dr. N. A. Barnicot	528
Determination of Arginine.—J. W. Janus	529
Electrical Activity in the Cockroach Cerebrum.—Donald M. Maynard	529
A New Quantitative Method for Antigen–Antibody Titrations in Gels.—Dr. Joseph G. Feinberg	530
Irradiation of Thiourea : Effect of Dose-rate upon the Chain Reaction.—Dr. W. M. Dale	531
Rhythmic Biting Activity of Certain East African Mosquitoes.—Dr. A. J. Haddow	531
Insecticide Resistance in *Anopheles gambiae* Giles.—R. Elliott and V. Ramakrishna	532
Normal Resistance-levels of *Anopheles gambiae* to Various Insecticides.—Dr. J. R. Busvine	533
So-called 'Glacier-Worms' in New Zealand.—Prof. N. E. Odell	534
Maintenance of Adult Mosquito Tissue in a Tissue-Culture Medium.—Dr. W. E. Beckel	534
Polymorphism of Alkyl Sulphate Soaps.—Prof. J. A. Prins and W. Prins	535
Low Audio-frequency Electromagnetic Signals of Natural Origin.—R. E. Holzer and O. E. Deal	536
Trinuclear Molecules in the Crystal Structure of Bisacetylacetonenickel (II).—Dr. G. J. Bullen	537
The Arrow of Time.—Prof. K. R. Popper	538

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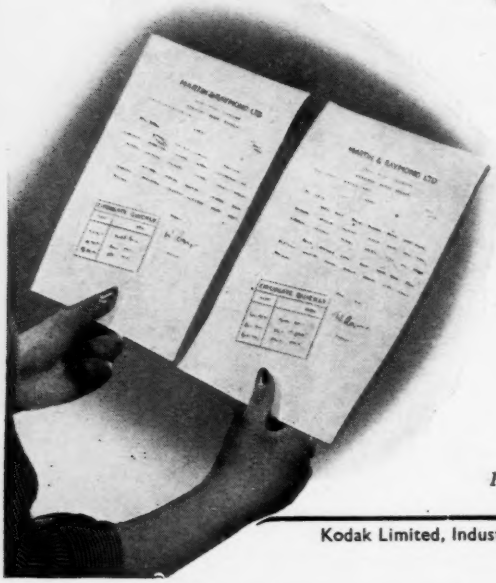

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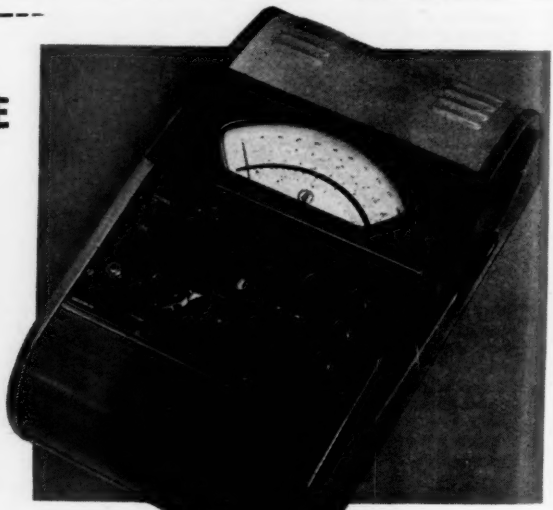

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SAFETY AND HEALTH IN INDUSTRY

THE annual reports of the Chief Inspector of Factories are primarily of interest to those directly concerned with health and safety in industry in Britain, and in so far as both health and safety depend increasingly on the knowledge and co-operation of the scientist, these reports are invariably of scientific interest. They often, however, are of a wider scientific or technical interest, as is well illustrated by the latest of these reports, that for the year 1954*. While particular and general trends in safety in health, welfare and hours of employment are reviewed in sections of the report devoted to these subjects, they are preceded by an introduction which gives a most useful survey of industrial developments during the year, bringing out a number of features of special interest to the scientist as well as to the technologist.

It is not surprising to find that the report notes that the factory population was the highest yet recorded in times of peace; but the number of power factories registered at the end of the year was 212,909, as against 214,020 at the end of the previous year, and the number of non-power factories also decreased from 21,032 to 18,955. The increase in the total number of persons employed is due to increases in the number of medium- and larger-sized factories, and for the second time since the War there was an appreciable increase in the total number of accidents —in factories from 158,597 to 161,458—but the accident-rate was slightly less. Doubt is expressed as to whether the same attention is being given to the training of women and girls as is given to that of men and boys, and while the importance of the human factor in accident prevention is far more widely realized than formerly, this report brings out well the supreme importance of management in effective organization for preventing accidents.

This is a point where the scientist or the technologist is directly concerned. It is not so much that his knowledge is required in devising appropriate measures, as that his interest is a vital factor in obtaining the necessary enthusiasm on the part of the works manager, the shed superintendent, the foremen and supervisors. Unless that is secured, it is almost impossible to make the worker himself aware of the part he can and should play in preventing accidents. In the present man-power situation, the elimination of loss of man-power due to accidents or sickness is of fundamental importance to Britain's economic effort, quite apart from those humanitarian considerations which will normally prompt every scientist or technologist to play his full part in preventing avoidable human suffering. The growing shortage of skilled and technically qualified workers during the past four years has enhanced the importance of training schemes for apprentices and others, and such training for production should never be divorced from training for safety. From the same economic consideration, the evidence presented in this report that the accident-rates for those aged sixty or more are less than for those in the prime of life is of general interest; but it should also be noted that quite small adjustments may make the lot of the elderly worker more comfortable and even safer. Apart from the slight contribution thus made to improving the man-power situation, such adjustments often have the further advantage that the older workers can retain their usual jobs with efficiency.

The importance of minor improvements in Britain's man-power resources is the more apparent in the light of the trends in industrial development stressed in this report. For example, trends in the design of factory premises are in the direction of single-story buildings with wide-span roofs; the particular example cited of retort houses in the gas industry, in which the gas producers are now built separate from, instead of integral with, the retorts, gives, with welded portals, a clear and unobstructed working space, and much improved lighting and ventilation, so providing conditions which are particularly helpful for the older worker. Again, the modern tendency to house chemical plant in a light weather-proof structure, besides being economical, greatly reduces the risk of explosion due to accumulation of inflammable dust or gases, while since much of this plant is remotely controlled and there are no men working full-time on it, no hardship is caused to operators. The report also emphasizes that mechanization of production continues to increase, particularly in industries in which raw or finished materials are handled in bulk, and sometimes the whole pattern of the manufacturing process is altered in consequence, while in a wide range of industry continuous methods are replacing batch processes.

Some of these last provide examples of one of the two particular trends to which the report directs attention. Methods of automatic production in one form or another have been a growing feature of industrial development for many years, and the real novelty of the present phase known as 'automation' lies in developments in the field of electronics during and since the Second World War. These, in turn, have led to entirely new conceptions of the master control of machinery and processes by means of a device called a computer, one type of which will issue predetermined 'orders' fed into it by means of punched-paper tape or magnetic tape. In this way, the operation of a machine or a series of machines may be controlled, quite independent of human intervention, to ensure that the final product comes up to specification.

The uses of automation, however, are not confined to the machine shop. It is beginning to appear, for example, in the manufacture of petroleum chemicals,

* Annual Report of the Chief Inspector of Factories for the year 1954. Pp. 265. (Cmd. 9505.) (London: H.M. Stationery Office, 1955.) 8s. net.

where the levels of liquids in large tanks or other containers can be accurately controlled, variations caused by fluctuating input or output being compensated. Further, it is possible in some cases by electronic means to draw off samples at various stages of the process, analyse them automatically and record the analyses by graphical means, the whole process being conducted on an instrument plant which may be several hundred yards away from the plant.

We are only at the beginning of such developments, but the report does not encourage excessive claims for the speed with which the automatic factory will be introduced. It is stated that automation has a considerable future in Britain for mass-production work, where long lines of the same type of product can be assured by public demand; but even in these fields no drastic overnight change is envisaged, and the automatic factory, full of complicated machinery controlled by only a few people, will take a long time to develop. None the less the importance of these trends has been noted by thoughtful people, and the whole subject is receiving serious consideration by those responsible for the future pattern of industry. The Factory Department believes that automation will eventually enhance the cleanliness as well as the safety of the factory. Automatic handling, too, is bound to increase and should eliminate many accidents in handling goods and materials.

While the report points out that, without an increase in shift working, automation would be uneconomic, it does not otherwise touch on the two most important implications of such developments. The first is one that is emphasized elsewhere in the report in discussing accident prevention. Just as the latter demands the full co-operation and understanding of the workers themselves, so the introduction of automation demands the co-operation and understanding of all those affected. It is not simply a matter of gaining their consent to shift-working. It means equally that the implications of redundancy and the transfer of labour, and not least the educational issues, must be fairly faced and frankly discussed with all concerned.

There is evidence enough in this report to show that not all managements have appreciated the importance of such co-operation and understanding even in relation to accident prevention. If Britain is to benefit to the full from the possibilities of automation, and to hold her position in competition with other nations who are adopting such methods, we must make full use of the breathing-space that the slow rate of introduction predicted in this report affords us to prepare the way for the changes and adjustments that will be required. The remarks on this subject should be weighed alike by trade unions and managements.

The implications of automation for technical education require particularly careful consideration; no plans for the expansion and development of the technical colleges are adequate for Britain's economic future if, in concentrating on the supply of technologists or even technicians, they ignore the needs of some measure of technical education for an increasing proportion of the operatives in industry. Here again is a matter demanding urgent attention, and much keener thinking than it appears to have received as yet. Its importance, moreover, is also emphasized by some of the comments in this report on the second of the particular trends in industrial developments which are noted, as well as in the remarks on the extension of electric supply and the use of electricity.

This second trend is the development of radiology in industry. This section of the report demonstrates more clearly than any other both the dependence of safety on the vigilance and co-operation of the scientist and technologist and the importance of technical education for those called upon to handle the apparatus and processes involved. The increasing use of gamma-ray radiographic sources seems to have supplemented rather than supplanted the use of X-rays for the radiography of castings and welds, and it is satisfactory to note that in recent years very few gamma-radiographic rooms newly built or specially adapted for the purpose have failed to meet the standards of the Factory Department. The rapid development of the electronics industry has increased the need for equipment incorporating piezo-electric quartz crystals serving as oscillators, resonators and frequency standards, and the cutting of these quartz crystals in the correct orientation depends largely on the use of X-ray crystallographic test equipment; the precautions to be taken in using this equipment were reviewed during the year in collaboration with the X-ray Analysis Group (Equipment Sub-Committee) of the Institute of Physics. As a result, the appropriate section in the Department's pamphlet, "Precautions in the Use of Ionizing Radiations in Industry", was revised when the pamphlet was reprinted in August 1954.

Iridium-192 continues to be the source most commonly used in industry for gamma-radiography. Use of tantalum-182 has practically disappeared, and thulium-170 has only gained slightly in popularity. Cobalt-60 provided the strongest gamma-ray sources used during 1954 in Britain for the radiography of castings and welds. The increasingly powerful sources of gamma-radiation being used by industry require corresponding advances in the design of their protective and operating containers, and during the year two manufacturers marketed new models of containers suitable for use with cobalt-60 sources up to about 10 curies in strength. Some incidents occurred during the year in connexion with radiographic sources and other radioactive materials, fortunately without serious consequences, though affording valuable lessons, of which due notice is being taken in considering statutory regulation. In view of the unique way in which radioisotopes can be used industrially to follow the mechanism of chemical, physical, engineering and biological processes, it is surprising how few uses are made of these materials as tracers in premises coming strictly under the Factories Acts. In this field the research laboratories attached to factories and the research stations of the Department of Scientific and Industrial Research have been far more active, and in various studies,

including the location of gas leaks, the travel of coal in retorts, paint sedimentation, metal extrusion and electroplating and mould metabolism, some eighteen radioisotopes are listed as having been used.

The scientific interest of the Factory Department's work is particularly apparent in such recent developments, though it is equally to be seen in the Department's research work designed to limit the dangers of explosions of dust, carried out in collaboration with the Department of Scientific and Industrial Research at the Safety in Mines Research Station, Buxton. Here attention is being turned, at the request of the Central Electricity Authority, to the problem of protecting the pulverized fuel plant used in power stations. Schemes of research with the object of limiting the explosions of gas and vapour have also been prepared, and it is hoped that they will be put into operation shortly, with the co-operation of the Department of Scientific and Industrial Research and the Ministry of Fuel and Power.

One encouraging feature of the report in regard to health in industry is that the general improvement in working conditions—such as cleaner premises, lighter and more cheerful surroundings, better washing and cloakroom facilities—is gradually changing the attitude of the operatives. They are tidier in themselves and more appreciative of the amenities provided. Most firms go well beyond legal requirements in regard to working conditions, though much could still be done to provide more comfortable conditions if thought were given to the use of modern equipment, to the provision of thermal insulation for the building and to the prevention of draughts. Substantial progress has also been made in the provision of natural and artificial lighting, and here again, while the scientific and technical expert has his part to play and perhaps is especially responsible for the initiative, the really encouraging feature is the evidence that the operatives respond when management takes the lead and seeks to stimulate their interest.

The report of the Chief Inspector of Factories makes it abundantly clear that the scientist and technologist have a decisive contribution to make to safety and health in industry, and that contribution is not made solely or even mainly through the 361 inspectors employed by the Factory Department, to the quality of whose work, efficiency and tact the report bears impressive witness. Industrial safety and health, like industrial efficiency, depend even more on the unceasing vigilance of the chemist, the physicist and the engineer, employed in industry at whatever level from works manager to process control, research, testing or construction. Much depends on their insight and initiative, their ability to co-operate with foremen and supervisors and operatives, and, though it is true that the Factory Department is finding difficulty in recruiting staff to fill its existing vacancies, it is not only as factory inspectors that those with scientific and technical qualifications can find expression for their concern for human welfare in industry. It is from within industry, by and large, that the attitude of management must be changed where necessary, not simply to fulfil existing requirements or to conform to the best practice rather than the legal minimum, but still more to undertake the constructive thinking that the adoption of new methods such as the change-over from batch to continuous processing, the introduction of new materials and new techniques like radioactive tracing, and, even further, the use of electronic and fully automatic methods demand.

The report gives no reason for doubting that it is possible to secure the necessary co-operation of the workers and their unions; but it will not be done without frankness, clear thinking and openmindedness on the part of unions as well as management. The Chief Inspector of Factories suggests that we still have time for such thinking, and for making adequate preparations for the changes required. This report for 1954 is valuable for the glimpse it gives of some of the problems which Britain must face if she is to adapt her economy to an age in which automation, nuclear power and radiology play an increasing part in industrial development. It is above all to be valued for its challenge both to unions and managements to face those implications as a matter of urgency, and to work out in co-operation and as expeditiously as possible the changes in industrial practices and in technical education which are required to enable Britain to enjoy the full benefits of technological advance with the minimum disturbance to industry or society.

FREUD'S "INTERPRETATION OF DREAMS"

The Interpretation of Dreams

By Sigmund Freud. (Translated from the German and edited by James Strachey.) Pp. xxxii + 692. (London: Allen and Unwin, Ltd., 1954.) 21*s*. net.

FREUD always looked on "The Interpretation of Dreams" as his most important work. This and the "Essays on the Theory of Sexuality" were the two publications that he regularly strove to keep up to date as fresh editions were required. Substantial additions and omissions, sometimes even entirely new sections, progressively appear in the seven German revisions, and Mr. James Strachey's version is in effect a *variorum* edition: every important departure from the original text is clearly indicated and dated, so that the inquiring reader is enabled to trace the gradual evolution of Freud's views.

The editor has furnished a long and valuable introduction, with illuminating quotations from Freud's own letters written both before and after the book appeared. As early as 1895, five years before it was published, Freud relates how, "not long ago, I was obliged to exchange my usual bed for a harder one; and, having as a result more numerous and more vivid dreams, I took the trouble to write them out and tried to solve them". A few months later he set down on paper a "Project for a Scientific Psychology" (recently published as an appendix to his correspondence with Fliess); and in the concluding part of the manuscript he sketches his first attempt at a coherent theory of dreams. Here he

put forward the novel and epoch-making suggestion that permeates the book itself, and so many of his later writings, namely, the close analogy between the mental mechanisms underlying dreams and those underlying neurotic symptoms.

One of the chief difficulties felt by the academic psychologist in assessing Freud's theory springs, as Mr. Strachey points out, from the fact that many of its basic concepts—"mental energy", "sum of excitation", "cathexis", and the like—are left undefined. In the "Project", however, we learn that "scientific psychology", as Freud originally conceived it, was to be formulated in terms of the anatomical doctrine of the neurone, which had recently been developed by German neurologists. This he proposed to combine with Helmholtz's doctrine that neural activity, like other physiological processes, must be interpreted in accordance with the principles of the conservation and transformation of energy. An inevitable corollary was the postulate of strict determinism which underlies his whole theory of dreams.

The working model elaborated on this twofold basis was curiously like that independently suggested by William McDougall in Britain a few years later. But, like McDougall, Freud quickly discovered that, when dealing with the mental processes of the individual, the only intelligible description would be one that is expressed in psychical rather than physiological terms. This radical change, as both writers recognized, involved the assumption that some of the most important processes in the mind must be regarded as wholly unconscious—a doctrine which eventually became the keystone of all Freud's theories. Accordingly, in "The Interpretation of Dreams" we no longer hear of "nervous excitation" flowing across the "contact-barriers" that separate one system of neurones from another, but of unconscious "wishes" tending automatically to fulfil themselves in the face of unconscious "resistance". But, despite this drastic change in vocabulary, the structural pattern attributed to the mind remains much the same as in the scheme originally outlined for the earlier interpretation in anatomical terms. Mr. Strachey, both in his introduction and in his explanatory footnotes, works out the parallel in some detail; and his explanations do much to elucidate the obscurer and more paradoxical features of Freud's own exposition.

Freud's style, as he himself realized, is tortuous and abstruse, with "involved and trailing sentences, bolstered up with sidelong glances and indirect phrases" (his own self-criticism). Mr. Strachey's translation, which is entirely new, skilfully surmounts the difficulties thus presented to the English-speaking student. At times the puns, the associations, the colloquial *double entendres*, on which many of the interpretations turn, are so peculiar to the German tongue that previous translators in despair have omitted many of the most typical dreams and even substituted examples of their own, either genuine or invented *ad hoc*. Mr. Strachey, quite rightly, has decided to keep scrupulously to Freud's own narrative, quoting and annotating the German where occasion demands. The index, bibliographies and supplementary notes are invaluable. As a result, both the psychological specialist and the general reader now have available a richly documented edition of what is after all one of the most original contributions to science published during the present century.

Cyril Burt

ANTIBIOTICS

Antibiotics Annual, 1954–1955

Proceedings of the Second Annual Symposium on Antibiotics. Edited by Dr. Henry Welch and Dr. Felix Marti-Ibañez. Pp. ix+1154. (New York: Medical Encyclopedia, Inc.; London: Interscience Publishers, Ltd., 1955.) 10 dollars.

Assay Methods of Antibiotics

A Laboratory Manual. By Dr. Donald C. Grove and Dr. William A. Randall. (Antibiotics Monographs, No. 2.) Pp. xxvi+238. (New York: Medical Encyclopedia, Inc.; London: Interscience Publishers, Ltd., 1955.) 5 dollars.

FOR anyone with an unsated appetite for new literature on antibiotics, the first of these volumes will indeed come as a bumper annual. This formidable mental meal constitutes the proceedings of the Second Annual Symposium on Antibiotics held in Washington, D.C., in October 1954. In format and content it is virtually indistinguishable from *Antibiotics and Chemotherapy* and *Antibiotic Medicine* and is, in fact, produced under the same auspices as these two journals. With more than 1150 pages and 172 papers, it almost equals in size their combined output for the year 1955 and clearly comprises a sizable part of the current literature on antibiotics. It is a pity, therefore, that those not attending the symposium had to wait some eight months—at any rate in Britain—for these admittedly well-produced proceedings.

The subject of antibiotics seems still to be in the exponential stage of development—no doubt because growth is plentifully nourished by dollars—and this volume gives an interesting cross-section of the subject towards the end of 1954. Thus, antibiotics are reported to be active *in vitro* or effective *in vivo* not only against a widening range of bacteria but also against viruses, yeasts, fungi, protozoa, and even tumour cells. Fourteen new antibiotics are reported. Many clinical papers deal with the use of established or newer antibiotics or of combinations of them with each other or with hormones or drugs, in a variety of maladies. Nearly fifty papers deal with some aspect of the tetracyclines. There is a timely summary of the untoward effects of the indiscriminate use of antibiotics, and a plea for the better training of physicians and medical students in their rational use. Greatly enhanced requirements are foreshadowed by the papers dealing with their place in veterinary medicine, animal husbandry and horticulture. All but seven of the papers are by Americans, though representatives of thirty-five nations were said to have attended the symposium.

The second of the volumes under review, instead of offering yet more new facts and theories about antibiotics, presents a neatly digested résumé of reliable methods for their assay, detection and testing. The names of the authors, and the fact that they write from the Antibiotics Division of the United States Food and Drug Administration, inspire confidence in the methods even when they are not the official Administration methods, and this confidence is enhanced the more one studies the book. The attitude is, not unnaturally, uncompromisingly American, and of the thirty-five references cited only two originate outside the United States. It follows that one will look in vain for certain methods much used in Britain, such as microbiological assays on large plates.

Successive chapters are devoted to penicillin, streptomycin, the tetracyclines, chloramphenicol, bacitracin, tyrothricin, polymixin, neomycin, erythromycin, carbomycin, viomycin, fumagillin, nystatin and anisomycin. Each chapter (with some exceptions) has four sections, dealing in turn with microbiological methods of assay, physical and chemical methods, assay of salts and pharmaceutical preparations, and determination in body fluids, tissues and animal feeds. Next follow chapters on the assay of mixtures of antibiotics—sixty-three mixtures are listed, mostly containing two active components—and on the identification of antibiotics by qualitative tests, by infra-red and ultra-violet absorption spectra (thirty-seven such spectra are given) and by optical and crystallographic properties. The procedure and specified amounts of various preparations to be used in toxicity, pyrogenicity and sterility tests; the determination of bacterial sensitivity to antibiotics; a chapter of miscellaneous tests and methods; and a list of media, buffers, reagents and apparatus conclude this unique book.

Discussion, where it occurs, is informative and brief; practical instructions are admirably clear and concise. Although, as mentioned, this book is selective and American in outlook, it contains a very large amount of useful information which it would be almost impossible to track down in the literature. One suspects that a good deal of it is being published here for the first time and is drawn from a critically accumulated store of experience. Anyone concerned with antibiotic assay or the other aspects covered here—whether through active interest or reluctant compulsion—will turn to this book with gratitude, tempered perhaps with momentary irritation that a method he values may not even be mentioned.

N. G. Heatley

MEASUREMENT AND APPLICATION OF NUCLEAR MOMENTS

Nuclear Moments

By Prof. Norman F. Ramsey. (Reprinted in part from Segrè (Editor), Experimental Nuclear Physics, Vol. I.) Pp. x+170. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 40*s*. net.

PROF. N. F. RAMSEY'S book on nuclear moments gives for the first time a comprehensive account of a series of experimental methods, the rapid development of which since 1945 has contributed so much to our knowledge of nuclear physics, of the solid state and of chemistry. Starting with two short chapters dealing with the elementary theoretical aspects of the interactions between nuclear moments and the electromagnetic field, he soon launches into an admirably lucid account of the various methods now available for the measurement of these interactions. Through a happy use of example and diagram, the author manages to translate his reader into the laboratory where he can see for himself, and compare, these various methods.

The final two chapters deal with the results of measurements of nuclear moments. The first of these includes a table of all nuclear moments determined up to 1952 and a brief discussion of shielding corrections. The second was added at a later date to the original version of the book, which was published as part of Vol. 1 of "Experimental Nuclear Physics", edited by E. Segrè. This deals exclusively with the many exciting applications of these techniques to chemistry and the physics of the solid and liquid states. It would be hard to find a more brilliant refutation of those who bewail the imagined fragmentation of science than this final chapter.

One thing only tends to mar an otherwise delightful presentation, namely, the hesitant way in which concepts are introduced in the early part of the book, sometimes very fully defined and sometimes completely undefined. Thus, for example, the vector J is introduced on p. 4, but is nowhere defined as being the resultant angular momentum of the extra-nuclear electrons. Similarly, on p. 29 a selection rule for the emission and absorption of radiation is introduced without a word of explanation, although many less difficult concepts are explained with great elaboration.

Notwithstanding this criticism, Prof. Ramsey's book will remain for many years as a standard reference work for those who wish to refresh their minds on some aspect or other of the measurement of nuclear moments and their applications, and in this respect the long list of references will be invaluable. The printers and binders have done an excellent job.

B. H. Flowers

COLOUR TELEVISION

An Introduction to Colour Television

By G. G. Gouriet. Pp. 72. (London: Norman Price (Publishers), Ltd., 1955. Published for the Television Society.) 8*s*. 6*d*. net.

THIS book is based on two lectures delivered to the Television Society in 1954 by G. G. Gouriet, who is on the research staff of the British Broadcasting Corporation. The first part gives an elementary introduction to tricolour analysis and synthesis, leading up to the proposition that, since three variables are needed to specify a colour sensation, the basic problem is the relatively simple one of conveying three pieces of information simultaneously. While the principle was demonstrated as long ago as 1928 by J. L. Baird, and made into a workable field-sequential system in the United States, the practical difficulties of fitting it into the existing framework of broadcasting are considerable.

The second part of the book explains the system devised by the National Television System Committee, which is 'compatible' (that is, able to give an ordinary picture with receivers not adapted for colour) and can operate within the necessarily restricted bandwidth limits. This requires two signals on two carrier waves, one of which, the luminance signal, provides the compatible picture. The other carries two colour-difference signals corresponding to co-ordinates on the chromaticity diagram, the double task being effected by making the two independent modulations 90° out of phase with one another. For this purpose the axes of the chromaticity diagram are shifted, so that instead of working in terms of primaries one signal operates along the orange–cyan line of the diagram and the other along the green–magenta line.

After explaining the principles adopted by the National Television System Committee, Mr. Gouriet

describes briefly the technical details of colour analysis in the tricolour camera by means of dichroic mirrors, and various means of colour synthesis at the receiving end. These include the three-tube method using dichroic mirrors, the shadow-mask system with a tricolour phosphor mosaic, and the Lawrence tube which is effectively a linear shadow-mask device. Finally, mention is made of the Valensi system, in which colour discrimination comparable with that of the eye is achieved (possibly more simply for transmission purposes) by treating the chromaticity diagram as a finite number of colour patches instead of a continuum.

The book is admirably illustrated in colour, and is very reasonably priced. It leaves one wishing one could have heard the original lectures.

G. R. Noakes

DYESTUFFS CHEMISTRY

The Chemistry of Synthetic Dyes and Pigments

Edited by H. A. Lubs. (American Chemical Society Monograph Series—No. 127.) Pp. xiv+734. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1955.) 148*s*. net.

According to the publisher's notice on the dust cover, "Here is without question the most authoritative work ever published on the subject of synthetic dyes". It should be authoritative in that it has been compiled by a formidable band of experts in the Du Pont Co., but whether it is the most authoritative is open to question. This is not an easy book to review; in fact, on a first cursory examination, the British reader is liable to form the opinion that something important is missing. It is an American book written primarily from an American point of view, which is not always quite identical with the British or European. There is no internationally agreed nomenclature for dyestuffs and intermediates; that used in America is not precisely the same as that used in Britain or in Germany, and the non-American reader must keep this point clearly in mind. The book has its shortcomings, particularly as a text-book suitable for students. For example, the historical development of the subject, as displayed in the various chapters, each dealing with a specific class of dyestuffs, is of necessity very scanty and may be misleading.

It is not always easy to follow the reasons for the development of a particular line of invention or to get a clear picture of how the chemistry of the subject developed. So much detailed information is given in such a concise form that some chapters tend to become not much more than a catalogue of the dyestuffs under discussion, with the briefest descriptions of how each is made. The literature citations, which are plentiful, may also give a false impression. Recent patent specifications with a tendency sometimes, but not always, to refer to the United States specifications rather than the original, and references to BIOS and FIAT reports predominate; thus the reader is referred mainly to very objectively written recipes for manufacturing particular dyestuffs and intermediates, and the uninitiated reader might conclude that reading dyestuffs chemistry is rather like reading Mrs. Beaton's cookery book.

It is, however, unfair to emphasize these shortcomings because Dr. H. A. Lubs and his collaborators have aimed at presenting a really up-to-date survey of dyestuffs chemistry, as it is at the present time, within the scope of a single volume. This they have achieved; they have produced a good book, and they are to be congratulated on their performance. As in all the monographs of the American Chemical Society, the printing of the text and the innumerable formulæ is excellent. Why, however, do publishers of such eminence persist in making difficulties for themselves and for their readers by using irregular hexagons in the formulæ of complex polycyclic compounds?

S. Coffey

A NEW SCHEME OF QUALITATIVE INORGANIC ANALYSIS

Qualitative Inorganic Analysis

A New Physico-Chemical Approach. By Prof. G. Charlot. (Translated from the Fourth French edition by Dr. R. C. Murray.) Pp. xi+354. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1954.) 42*s*. net.

Many teachers feel that the classical method of qualitative analysis is uninteresting. It certainly familiarizes the student with the appearance and chemical properties of a large number of important substances which he might otherwise never see, and if properly taught it can be used to illustrate many aspects of physical chemistry. The use of newer organic reagents in colour reactions suffers from the objection that the student at that stage has no idea of the structure of the reagent or what is happening in the process, and the procedure is empirical in the extreme. Teachers may think that analytical chemistry as taught is too little related to what is done in works laboratories; but each works has its own techniques, and the object of a course in qualitative analysis should be to teach chemistry.

From time to time modified schemes of analysis have appeared, and this book gives one in which group separations are abandoned and detections are by specific reagents in solution. The first part contains a long description of various branches of inorganic and physical chemistry which are at least as well described in separate treatises on those subjects. The methods used depend largely on *p*H and redox potential control and the formation of complex compounds. Solvent extraction is also used. The practical part of the book goes through a number of groups of elements arranged according to the basis of the scheme. Some less common elements are included. Extensive tables of equilibrium constants and diagrams of solubility products as functions of *p*H as well as redox potentials are given, and even in the second part of the book the text is interrupted by long digressions on theory.

As an alternative to the usual method, the procedure described in the book is certainly worth a trial. I think, however, that the average student would be bewildered by the book. If given a substance for identification, he would not know where to begin. A book on qualitative analysis should serve as a guide to such an identification and not a text-book of physical or inorganic chemistry. The book should be examined by teachers of qualitative analysis; even if they do not feel disposed to adopt its methods, they will find much in it which will be helpful in other parts of their work.

J. R. Partington

An Introduction to the Principles of Chemistry

By Prof. L. H. Cragg and Prof. R. P. Graham. Pp. ix+740. (London: George G. Harrap and Co., Ltd., 1954.) 35*s*. net.

THIS book, by two Canadian teachers, deals with what used to be called 'theoretical chemistry' and is not a text-book of inorganic chemistry. In the preface it is truly said that students from school beginning a course in a university are disheartened if their hardly won knowledge, rudimentary and sometimes incorrect as it may be, is ignored and they are compelled to go through books containing much that they already know. The authors assume that the reader has such a knowledge, and they attempt to extend and correct it.

Among the topics dealt with are the discovery and classification of the elements, atomic and molecular structure, the kinetic theory, solutions, reaction velocity and equilibrium, electrolytes, energy changes, nuclear phenomena and trans-uranic elements, applications of nuclear science, and the use of less common elements in industry. The literary style is excellent, and the book is well illustrated. Care is taken to explain all difficult points (the section on the kinetic theory of gases is notably good in this respect), and there are good exercises and hints for further reading at the ends of the chapters.

In many places the authors attempt to inspire the young reader with a real love of science and make it clear that much remains to be done in known fields, not to mention much that may yet be quite unknown. What may be called the research spirit enlivens the whole text. This is a notably good book which every teacher of chemistry ought to see. Although very modern in content and inspiration, it frequently uses the historical approach and something is said of the personalities whose work has built up the science of chemistry. Most young students are attracted by such a treatment, as the authors well know. It can win new workers in the field, and the book openly encourages its readers to join the ranks of the discoverers. The book is very attractively produced, and its price is moderate.

Experimental Inorganic Chemistry

By Dr. W. G. Palmer. Pp. xx+578. (Cambridge: At the University Press, 1954.) 50*s*. net.

COURSES in practical inorganic chemistry have always been a problem for the teacher. Most students have done parts at school, and the severe discipline called for in quantitative inorganic analysis is apt to be irksome as compared with the rather untidy progress through a course of organic preparations.

Dr. W. G. Palmer has had the ingenious idea of combining the analysis with the preparative work, and of introducing the preparation of substances not too familiar to the students but of undoubted interest and importance. The first hundred or so pages give a concise survey of modern theory in inorganic chemistry, and the book then goes through the preparations and analyses in the order of the elements in the periodic table. A compound is first prepared and then quantitatively analysed. It is certain that this plan will enliven the subject, make it more intelligible and interesting, and give the student a better appreciation of inorganic chemistry as a whole.

At the end of each section there is a short list of literature references, which are intended to be read. The theory is extended in the introduction to each group, so that the book provides a concise text-book of inorganic chemistry as well as a practical course. Many of the exercises could be done at school, and all are suitable for university courses. Dr. Palmer's book can be strongly recommended to all concerned with teaching practical inorganic chemistry, and every teacher of the subject in school or university should have a copy.

Sunspot and Geomagnetic-Storm Data derived from Greenwich Observations 1874–1954

Compiled under the direction of Sir Harold Spencer Jones. Pp. viii+106. (London: H.M.S.O., 1955.) 25*s*. net.

FOR the past eighty years the annual volumes of the "Greenwich Magnetic and Meteorological Observations" and "Greenwich Photoheliographic Results" have served to tabulate data on geomagnetic storms and measures of sunspot areas and positions. This wealth of material has now been collected in a single volume which includes catalogues of the larger sunspots and of great and small geomagnetic storms, and tables of areas of sunspots and faculæ with detailed information on the latitude distribution of the sunspots.

A feature which will be welcomed by many workers is the adoption of the calendar month for the mean areas of sunspots and faculæ; this will go far to justify the hope of Sir Harold Spencer Jones that "this compilation . . . will be useful to those investigating solar-terrestrial relationships". Each section contains explanatory notes and references to published papers; some diagrams have also been included, among which it is interesting to find Maunder's 'butterfly' diagram, which has been brought up to date and now contains more than seven complete cycles.

Thermionic Valves 1904–1954

The First Fifty Years. Pp. iii+70. (London: Institution of Electrical Engineers, 1955.) 9*s*.; or 4*s*. to members.

A DETAILED account of the celebrations, held in November 1954, of the jubilee of the thermionic valve has already been published in *Nature* (**174**, 1076; 1954). As a record of the proceedings which took place on that occasion, the Institution of Electrical Engineers has published a most attractive book entitled "Thermionic Valves 1904–1954: The First Fifty Years". The frontispiece is a photograph of the original Fleming diode; and this is followed by an appreciation of Sir Ambrose Fleming and Dr. Lee de Forest by Captain C. F. Booth, together with a copy of both the provisional and complete specifications of British Patent No. 24850 : 1904, applied for by Fleming on November 16, 1904.

The next thirty pages of the book comprise the full texts of the opening address of the Marquess of Salisbury, and the three lectures given by Prof. G. W. O. Howe, Sir Edward Appleton and Dr. J. Thomson, on the occasion of the meeting at the Institution last November. The last two lectures are well illustrated by some excellent diagrams and photographs of typical valves and circuit arrangements. The book is completed by a catalogue of 242 types of thermionic valve, with nearly fifty photographs, representative of experiment and production over the past fifty years.

All those interested in the history of the thermionic valve, and the part it has played in the development of telecommunications and electronics, will welcome this publication. R. L. S.-R.

NEW X-RAY DATA ON COALS

By L. CARTZ, R. DIAMOND and P. B. HIRSCH
Crystallographic Laboratory, Cavendish Laboratory, Cambridge

FOLLOWING a recently published investigation on vitrains[1], further work has been concentrated on three topics: (1) examination of other coal types; (2) examination of coal extracts; (3) study of the carbonization of coals. While the results to date are in most cases only preliminary, certain qualitative conclusions may already be drawn from them. Full details will be given later.

Examination of Other Coal Types

Coal petrologists have long recognized different petrographic constituents of coals[2]; among these vitrinite, exinite, micrinite and fusinite are the most important. These petrographic components differ both in optical properties and chemical composition. Generally, the exinite component of a given coal has a relatively high hydrogen content and the micrinite a relatively low hydrogen content compared with that of the vitrinite. A preliminary examination has been made of a series of black durains, rich in exinite, and a series of grey durains, rich in micrinite. The work on untreated durains is difficult owing to high ash content; however, preliminary tests carried out at the Coal Survey Laboratory, Sheffield, indicate that, at least in the case of the grey durains, the mineral matter can be removed by treatment with hydrochloric and hydrofluoric acids without appreciably altering the structure.

(*a*) *Black durains.* Fig. 1 (*a* and *b*) shows low-angle X-ray patterns from two durains of different rank. The patterns can be divided into two parts: the first consists of diffuse scattering or a band at about 20 A. at low angles, together with the 002 band (due to the stacking of the layers) at higher angles; this part of the pattern is somewhat similar to that of vitrains of similar rank, except that the 002 band is considerably sharper, and for the low-rank durain the diffuse low-angle scattering is not as prominent as for the corresponding vitrains. This part of the pattern bears a very strong resemblance to that obtained from micrinite (see below). The second part of the

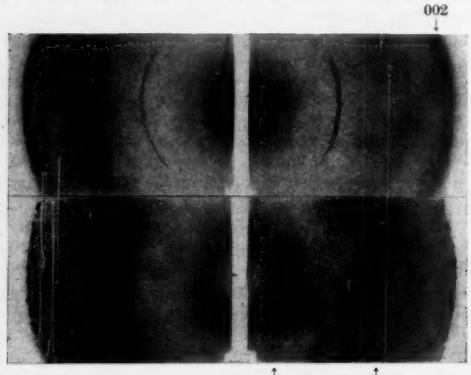

Fig. 1. Low-angle photographs of two black durains, (*a*) 82·4 per cent carbon, (*b*) 87·9 per cent carbon, showing the 002 and 'γ' bands. In the case of the higher-rank durain, there is a band at about 20 A., whereas for the lower rank, only diffuse scatter at very low angles is observed. The faint, spotty lines are due to traces of mineral impurities

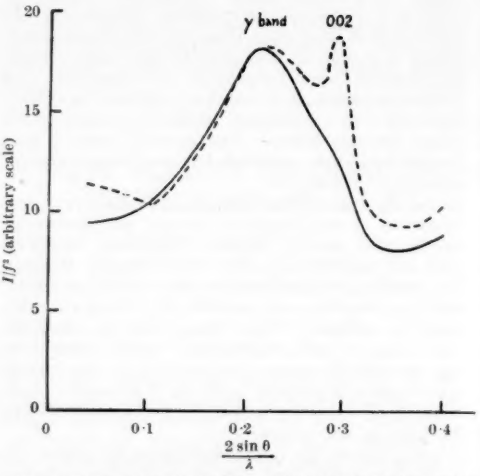

Fig. 2. Low-angle scattering from a black durain (dashes) and an exinite-rich concentrate (full-line). (*f* is atomic scattering factor, 2θ is angle of scatter, λ(A.) is the X-ray wave-length)

pattern, and the dominant feature at low angles, is the very broad band at about 4–5 A., which does not occur for vitrains. This band occurs at the same spacing as the 'γ' band found by Blayden, Gibson and Riley[3], and it is likely that the 'γ' band was indeed due to the presence of exinite in the specimen examined by these workers. Nelson[4] has also reported the occurrence of the 'γ' band in durains but not in vitrains.

In order to decide whether the two parts of the patterns arise from different phases in the coal, an exinite-rich concentrate was prepared from one of the durains. Fig. 2 shows intensity curves as a function of $2 \sin \theta/\lambda$ (2θ is scattering angle, λ is wave-length) from the original durain and from the concentrate. It appears that in the exinite-rich concentrate both the band at about 20 A. and the 002 band are considerably reduced in intensity relative to that of the 'γ' band; this indicates very strongly that the 'γ' band is associated with the spore material (exinite) whereas the rest of the pattern is due to another phase. Examination of slabs has shown that while the layers of the vitrain-like phase have a preferred orientation parallel to the bedding plane, this is not the case for the structure giving rise to the 'γ' band.

At high angles, only the two-dimensional diffraction bands (due to the structure within the layers) occur, and these are very similar to those obtained from vitrains.

These observations indicate in the first place that exinite, like vitrinite, consists mainly of condensed aromatic layers, although there may be small but important differences in the diameter and distortion of the layers. The 'γ' band is thought to arise from irregular packing of these layers, and the greater spacing of this band compared with that of the 002 band may perhaps be due to buckling of the layers or to the presence of more aliphatic material around

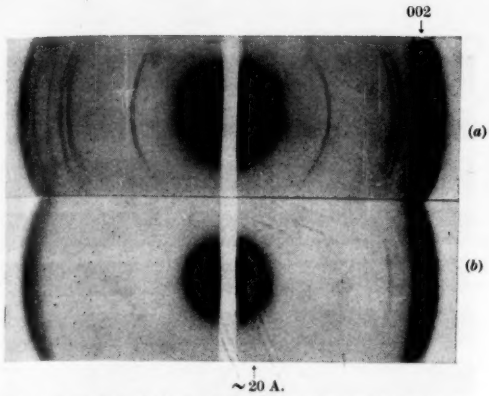

Fig. 3. Low-angle photographs of two grey durains (*a*) 82·3 per cent carbon, (*b*) 91·4 per cent carbon, showing the 002 band. In the case of the higher-rank durain, a band at about 20 A. is observed, there being only diffuse scattering for the lower-rank coal. The faint lines are due to traces of mineral impurities

the edges of the aromatic systems, which may prevent the layers from packing at a distance closer than that possible for aliphatic chains (also about 4–5 A.). This suggestion is in agreement with the fact that the spore material is relatively rich in aliphatic material (Brown, J. K., private communication).

(*b*) *Grey durains.* Fig. 3 shows low-angle patterns from two grey durains of different rank. The patterns are similar to those of the black durains, except that the 'γ' band is relatively unimportant compared to the 'vitrain-type' pattern. As already mentioned for the black durains, their pattern differs mainly from that of the vitrains in the greater sharpness of the 002 band, and in the decreased intensity of the diffuse scattering at very low angles for the low-rank coals. At high angles the pattern again consists of the usual two-dimensional bands, from which it appears that the layers are probably of somewhat larger diameter, or more perfect, than those of the vitrains. The consequent improved packing of the layers would also account for the enhanced sharpness of the 002 band. Apart from these differences, the series of patterns from grey durains of different rank appear to change in a manner similar to that seen in vitrains, that is, with increasing rank the diffuse low-angle scattering decreases, and a band appears at about 20 A.

These experiments indicate that exinite and micrinite really do represent structurally distinct phases; while the basic aromatic structure is similar, the packing of the layers in the micrinite of a grey durain is better, and in the exinite of a black durain worse, than for the vitrains. This may be a function of the perfection of the layers or particularly of the non-aromatic edge groups. It appears that the greater the content of hydrogen and of aliphatic material, the more difficult it becomes for the layers to pack together.

Extracts and Residues

A series of ethylene diamine extracts from different coals has been examined. While the patterns at high angles are very similar to those of the vitrains, important differences occur at low angles. In the case of the lowest-rank coal (Fig. 4*a* (80 per cent carbon)), a new band appears in the extract at about 12 A. (that is, $2 \sin \theta/\lambda \simeq 0{\cdot}08$), which is not present in the parent coal, and the low-angle scattering decreases. The same is observed with a parent coal of 78 per cent carbon. For a coal of 84 per cent carbon, a band appears in the extract at about 16 A., whereas for a coking coal of 89 per cent carbon (see Fig. 4*b*), which shows a strong band at about 20 A. in the original vitrain, the band moves to about 30 A. in the extract. The tentative interpretation of these results is that the extracted material is to some extent disentangled and can 'crystallize' to form the

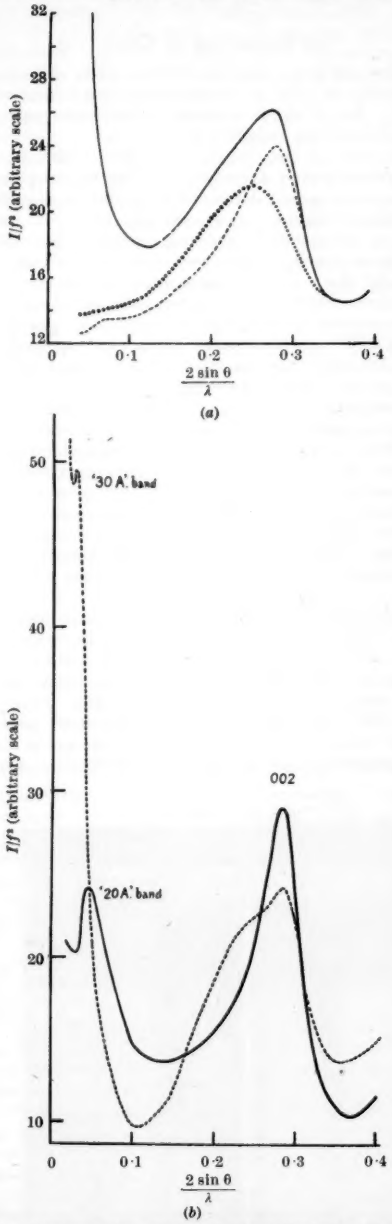

Fig. 4. (*a*) Low-angle scattering of extract (dashes), residue (dots) and original coal (full-line) of a low-rank coal of 80 per cent carbon content. (*b*) Low-angle scattering of extract (dashes) and original coal (full-line) of a coal of 89 per cent carbon content. The residue is almost identical with the original coal

same type of 'micro-pore' structure as occurs in the coking coals.

The residues left after extraction show, in the case of the low-rank coals, a marked increase in the broadening and a movement to lower angles of the 002 band and a decrease in the low-angle scattering (see Fig. 4*a*). These results indicate that, after extraction, the material left behind expands locally in the direction normal to the layers, at the same time closing some of the larger pores.

Carbonization of Coals

A caking and a coking coal have been carbonized at intervals of 100° C. from room temperature to 1,000° C. Fig. 5 shows a series of low-angle patterns obtained from the caking coal.

In the case of the caking coal, up to 400° C. the low-angle scattering decreases and the band at about 20 A. becomes more intense. Above 500° C. the 20-A. band again becomes more diffuse, until at about 700° C. it is almost completely replaced by diffuse low-angle scattering. The two-dimensional bands at high angles show that no growth of the layers occurs before about 500° C.; growth begins to be appreciable from about that temperature and probably accelerates at about 700° C. It appears, then, that up to about 500° C. the only directly observable changes are the closing of the larger pores and an improvement of the micro-pore structure; the latter, however, is at no stage as pronounced as in the coking coal. From about 300° C. these changes are accompanied by an evolution of volatile matter which proceeds at a maximum rate at about 450° C. The growth of the layers above about 500° C. is accompanied by increased diffuse low-angle scattering, suggesting a 'clustering' process leading to a wide distribution of layer diameters and a wide distribution of larger pores.

In the case of the coking coal, which shows a strong 20-A. band in the unheated state, very little change occurs up to about 500° C.; above that temperature the patterns are similar to those of the caking coal. The onset of growth also occurs at about 500° C., and detailed numerical analysis indicates that the true mean layer diameter is linear with temperature from 500° to 1,000° C., varying

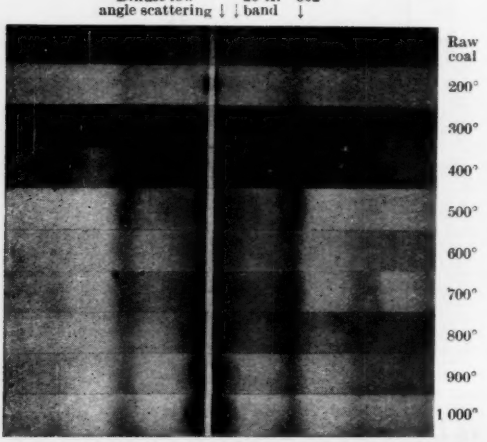

Fig. 5. Low-angle scattering from a carbonized caking coal initially of 84 per cent carbon content. Temperatures in degrees centigrade

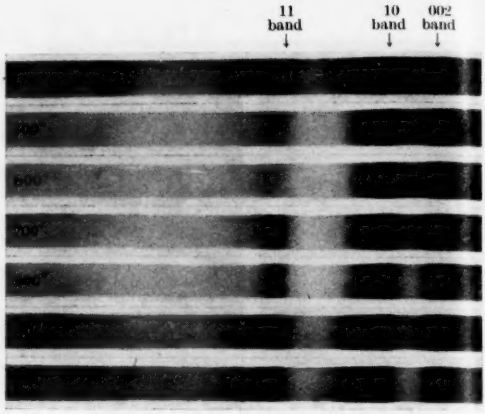

Fig. 6. High-angle photographs from a carbonized coking coal initially of 89 per cent carbon content. Temperatures in degrees centigrade

from 7 A. up to 14 A., with the high-temperature specimens showing some very small molecules and some larger than 20 A.

Fig. 6 shows the high-angle photographs from the coking coal, demonstrating the increase in sharpness of the 10 and 11 bands as the temperature rises beyond 500° C.

It would be premature at this stage to attempt to draw definite conclusions about the carbonization process. It is interesting to note, however, that the temperature at which growth becomes appreciable (500° C.) is in the same range as that in which a secondary reaction takes place; this reaction, on the evidence of infra-red spectroscopy[5], has been interpreted in terms of cross-linking, and is accompanied by the removal of aromatic hydrogen and hydroxyl groups. At this temperature also the concentration of 'free radicals' is a maximum[6]. The increase in layer size at higher temperatures is accompanied by a decrease of electrical resistance.

The diffraction pattern of the caking coal at 500° C. differs from that of the coking coal at 500° C. in that the band at 20 A. is not so pronounced in the former as it is in the latter. This may be correlated with the fact that the carbonized coking coal contains fewer hydroxyl groups than the caking coal[6]. The same correlation is found in the coalification series[7], where the band at 20 A. increases in intensity as the proportion of hydroxyl groups decreases.

One other feature of the low-angle photographs for the caking coal, which can be detected by eye and confirmed by photometry, is the reduction in intensity at high temperatures in the region midway between the 002 band and the direct beam. This can be interpreted as a reduction of the fraction of layers which occur singly.

A more detailed account of this work is to be published later, in which quantitative data and interpretations will be given and in which proper acknowledgment will be made of our indebtedness to a number of colleagues.

[1] Hirsch, P. B., *Proc. Roy. Soc.*, A. **226** 143 (1954).
[2] Francis, W., "Coal" chapter 6 (Arnold, London, 1955).
[3] Blayden, H. E., Gibson, J., and Riley, H. L., Proc. Conf. Ultrafine Structure of Coals and Cokes, 176 (B.C.U.R.A., 1944).
[4] Nelson, J. B., *Fuel*, **33**, 153 (1954).
[5] Brown, J. K., *J. Chem. Soc.*, 752 (1955).
[6] Ingram, D. J. E., Tapley, J. G., Jackson, R., Bond, R. L. and Murnaghan, A. R., *Nature*, **174**, 797 (1954).
[7] Brown, J. K., and Hirsch, P. B., *Nature*, **175**, 229 (1955).

CHROMOSOMES, GENES AND MACROMOLECULAR SYSTEMS*

By Prof. FRANCIS O. SCHMITT
Biology Department, Massachusetts Institute of Technology, Cambridge, Mass.

Structure of Living Systems

IT has long been supposed that organization is one of the most characteristic properties of living systems. This applies at all levels of complexity from the small metabolite molecules through the larger protein molecules, macromolecules and subcellular organelles to cells, organisms and groups of organisms. The temporally and spatially ordered coupling of energy upon the macromolecular lattices of protoplasm is at the core of most processes of cellular biology. Therefore it is most important that investigations be made of the structure and properties of this molecular machinery. Fortunately, such investigations are being actively pursued in many laboratories both from the more to the less complex (that is, studies of cellular ultra-structure by the electron microscope) and in the reverse direction (that is, crystallographic studies of the detailed structure of protein and nucleic acid macromolecules by X-ray diffraction, based upon detailed studies of the simpler single amino-acids and lower peptides).

From such studies and from physical-chemical investigations of extracted and purified materials it has been found in a number of cases (myosin, tropomyosin, paramyosin, collagen, fibrinogen, keratin) that the characteristic particle is a long thin macromolecule 15–20 A. in diameter and some hundreds or thousands of angstrom units in length. These macromolecules may be built up by adlineation of smaller units or precursors; but the full biological and chemical properties are manifested only by the larger macromolecular units. It is in these particles that the complementarity and specificity reside in so far as processes of building up and chemical interaction are concerned.

In few cases has it been possible thus far to observe the individual macromolecules directly with the electron microscope. However, under appropriate conditions, the macromolecules interact with each other to form fibrous aggregates which manifest in the electron microscope a very regular periodic cross-striated appearance. The axial period and the detailed intraperiod fine structure are characteristic of each protein. In a few cases the structure and modes of aggregation of the macromolecules have been deduced from the structure observed in the electron microscope. Collagen is one of these systems[1,2] and it will serve to illustrate what might prove to be typical of other fibrous proteins.

The macromolecular unit of collagen is a particle of dimensions about 14×2900 A.^{3}. It is thought to be composed of three polypeptide chains in helical configuration[4–7]. The sequence of amino-acid residues in the macromolecular chains is presumably constant and specific. Therefore, the types of side-chains and their distribution along the chains are also specific. The individual tropocollagen macromolecules are themselves not banded; but when they aggregate with each other laterally to form a fibril the side-chain interaction produces regions of relative disorder or order (in the crystallographic sense) and this leads to the production of bands and interbands, respectively, in the resulting fibril, according to the suggestion of Bear[8]. Depending upon the pattern of side-chain interaction and the stability of the resulting aggregate a variety of geometrical forms might be possible. In the case of collagen at least five band patterns and several intermediate forms have been observed, and these are thought to arise by different aggregation forms of the tropocollagen macromolecules. Thus if the chains are polarized all in the same direction, 'segmental long-spacing' structures may be formed if the chain-ends are in register; if the chain-ends are staggered by a specific fraction of the macromolecular length the 640-A. type structure, characteristic of native collagen, is formed. If the macromolecular chains are running in opposite directions (antiparallel array) and chain-ends are approximately in register, the axially symmetrical 'fibrous long-spacing' structures are formed[1,2].

The very significant fact which emerges from the collagen experiments is that, although the types of aggregation possible depend upon the specific composition and molecular architecture of the tropocollagen particle, that which will occur under any particular conditions depends very sensitively upon the chemical environment (pH, ionic strength, presence of certain types of substances, etc.). The transitions from one structure to the other are freely reversible, and relatively subtle changes in the chemical environment may change the structural pattern formed on reconstitution.

Somewhat similar macromolecular interactions probably occur in the case of paramyosin reconstituted from acid[9] or near-neutral salt solutions[10].

Constitution and Properties of Chromosomes

From this background of experience regarding interaction properties of protein macromolecules certain possibilities concerning the constitution and properties of chromosomes and genes suggest themselves which, so far as I am aware, have not thus far been pointed out and which may have very far-reaching importance for genetics and for the study of differentiation and morphogenesis.

Although knowledge about the proteins and nucleic acids of chromosomes is still very limited[11,12], it seems clear that the deoxyribonucleic acid (DNA) and possibly certain of the proteins exist as long thin macromolecules in the normal chromosome. When chromosomes (as in sperm heads) are extracted under the mildest conditions, the extracted macromolecules may be very long (30,000–40,000 A.) and thin (about 20–25 A.)[13,14]. How many species of deoxyribonucleic acid and protein macromolecules exist in the chromosome is unknown, and fractionated preparations obviously contain numerous constituents.

The giant salivary gland chromosomes of certain insects are characteristically banded when viewed in ultra-violet light or after appropriate staining. In contrast with the band patterns of fibrous proteins,

* Based on a paper read before the American Philosophical Society on November 10, 1955. The detailed paper will be published in the *Proceedings of the American Philosophical Society*.

those of the giant chromosomes are aperiodic rather than periodic; there is no true repeat over the extent of the chromosome (about 100μ). The positions of the various genes have been localized in the genetic (linkage) maps, with respect to these microscopically visible bands. The bands and interbands, which have highly characteristic positions, dimensions, density and staining characteristics, represent regions of relatively high or low deoxyribonucleic acid-to-protein ratios, respectively, and must be explicable in terms of a specific packing of the elongate macromolecules which compose the chromosomes.

Aggregation of Macromolecules

As in the case of the submicroscopic band patterns of the fibrous proteins, the microscopically visible bands of the giant chromosomes may, for present purposes, be thought of as resulting from various types of aggregation of the constituent macromolecules, chiefly those of deoxyribonucleic acid and protein. At least five different band patterns (as well as various intermediate forms), representing as many different types of aggregation of the tropocollagen macromolecules, have been observed in systems containing only a single species of protein macromolecule, collagen. In chromosomes let it be supposed that a limited number of *species* of deoxyribonucleic acid and of protein macromolecules exist, together with histones and protamines. Various types of aggregation of the several species of deoxyribonucleic acid and protein macromolecules may occur. These include aggregation of individual species of deoxyribonucleic acid or of protein with themselves, with other species of deoxyribonucleic acid or protein (as well as with histones and protamines).

Each group of interacting macromolecules may aggregate in parallel or antiparallel array, with ends in register, out of register, or staggered according to some particular pattern of the reacting groups. In this way it would be possible, even with a relatively limited number of species of deoxyribonucleic acid and protein macromolecules, to produce specific aperiodic patterns of considerable length and having many bands, such as occur in the giant chromosomes.

Continuing the analogy, it may be suggested that, given a certain concentration of the various types of native deoxyribonucleic acid and protein macromolecules, the banded chromosomes may spontaneously form (be reconstituted) if all the factors of the chemical environment are appropriately adjusted. It would thus be unnecessary that the chromosome be reduplicated *as a whole*. Instead the constituent native macromolecules of deoxyribonucleic acid and of protein may be synthesized (presumably in the nucleus) and, assuming that their concentration has reached a certain minimal level, they will spontaneously aggregate in a manner characteristic of the native chromosome. This hypothesis would require that the cell be capable of maintaining a highly characteristic chemical environment, because only under such conditions would the various macromolecules spontaneously form the same characteristic, stable macromolecular pattern required by the cytological and genetic data.

Theory of the Gene

Still another, highly significant, possibility follows from the above view. This has to do with the gene itself. The now largely abandoned 'point determiner' theory of the gene considers that the genes occur as molecules or particles arranged *seriatim* along the chromosome, like beads on a string. Quite possibly the inclination on the part of those examining chromosome structure in the electron microscope to pay especial attention to any particulate or bead-like structures which may be observed is another indication of the point determiner theory in modern guise. Recent experiments on the transforming factor and on bacterial viruses focus attention on the deoxyribonucleic acid macromolecule as such, and it is not incompatible with genetic data to regard highly localized regions of the deoxyribonucleic acid macromolecules, possibly even single turns of the double helix, as representing individual genes.

However, it is also possible that the chemical groupings which constitute the genes are not macromolecules or even small regions of *individual* macromolecules. Rather, the chemical groupings corresponding to genes may occur in juxtaposition on two or more adjacent macromolecules which may be the same or different species of deoxyribonucleic acid or of protein (a nucleoprotein may, in fact, be considered to be just such a lateral union between deoxyribonucleic acid and protein macromolecules linked by electrostatic or hydrogen bonds).

If this be the case, then with the same population of macromolecules of deoxyribonucleic acid and proteins, it may be possible to achieve or 'activate' a wide variety of biocatalysers depending on which species of macromolecules are in contact and on the way in which the constituent macromolecules are arrayed with respect to each other laterally, that is, in parallel or antiparallel array, with ends in register or in some kind of staggered array. Which arrays are stable under particular conditions will depend importantly on factors in the chemical environment. 'Activation' or 'inactivation' of genes might then occur merely by change in the relationship between particular macromolecules laterally without essential alteration of the constituent macromolecules themselves. Such changes might well result from changes in the chemical environment such as probably occur in processes of differentiation and morphogenesis. The resulting change in macromolecular relationship might bring into juxtaposition new chemical groupings which constitute different catalytic groups (genes); these in turn influence reactions which contribute to further steps in differentiation and development, thus constituting the feedback type of mechanism which must almost certainly be involved in the highly regulatory processes of development.

Phenomena such as position effect and pseudoalleles make the classical corpuscular picture of the gene obsolete in modern genetics. As suggested recently by Goldschmidt[15], the field of macromolecular chemistry must support and contribute to our revised notions of the gene. It is hoped that the suggestions put forward in this article will constitute a step toward bringing together biological observations and recent advances in macromolecular chemistry.

At the present time these suggestions must be regarded as purely speculative, based on properties observed experimentally in certain macromolecular systems. However, in collaboration with Dr. Herman W. Lewis, I have initiated attempts to obtain experimental evidence for at least one aspect, namely, the possibility of taking banded giant chromosomes apart into their constituent macromolecules in appropriate solutions and afterwards, by alteration of the chemical environment, to reconstitute banded structures

(hopefully, though not necessarily, with a band pattern like that found in normal chromosomes). Progress in these experiments will be reported in due course.

[1] Schmitt, F. O., Gross, J., and Highberger, J. H., *Symp. Soc. Exp. Biol.*, **9**, 148 (1955).
[2] Schmitt, F. O., Gross, J., and Highberger, J. H., *Exp. Cell Res.*, Suppl. **3**, 326 (1955).
[3] Boedtker, H., and Doty, P., *J. Amer. Chem. Soc.*, **77**, 248 (1955).
[4] Ramachandran, G. N., and Kartha, G., *Nature*, **176**, 593 (1955).
[5] Ramachandran, G. N., and Kartha, G., *Proc. Indian Acad. Sci.*, **42**, 215 (1955).
[6] Rich, A., and Crick, F. H. C., *Nature*, **176**, 915 (1955).
[7] Cowan, P. M., McGavin, S., and North, A. C. T., *Nature*, **176**, 1062 (1955).
[8] Bear, R. S., "Adv. Protein Chem.", **7**, 69 (1952).
[9] Hodge, A. J., *Proc. U.S. Nat. Acad. Sci.*, **38**, 850 (1952).
[10] Locker, R., and Schmitt, F. O. (unpublished).
[11] Davison, P. F., Conway, B. E., and Butler, J. A. V., "Progress in Biophysics", **4**, 148 (1954).
[12] Allfrey, V. G., Mirsky, A. E., and Stern, H., "Adv. Enzymol.", **16**, 411 (1955).
[13] Reichmann, M. E., Rice, S. A., Thomas, C. A., and Doty, P., *J. Amer. Chem. Soc.*, **76**, 3047 (1954).
[14] Doty, P., Proceedings Third International Congress of Biochemistry, Brussels, 1955 (in the press).
[15] Goldschmidt, R. B., "Theoretical Genetics" (Univ. Calif. Press, 1955).

OBITUARIES

Prof. Émile Borel

THE rapid progress of mathematical analysis in the early years of the present century was due in considerable measure to the influence of the great French school, of which Émile Borel, whose death occurred on February 3 at the age of eighty-four, was a leading figure. To high creative ability, he added expository skill and unusual powers of organization; his name is known throughout the mathematical world not only for the doctrines to which it is attached—the Heine–Borel theorem, the Borel summation process, Borel sets—but also for the vast co-operative enterprises which he directed.

The theory of sets was more warmly welcomed in France, so Cantor thought, than in its German home; certainly the volumes of Jordan's classic "Cours d'Analyse" suggested that irksome continuity restrictions could only be removed by some method more powerful than that author's theory of content. In 1898, Borel's "Leçons sur la théorie des fonctions" provided a new theory of measure, while Baire's thesis on discontinuous functions appeared in the same year; and thus the way was open for the remarkable advances of the next decade. The booklet of 1898, based on lectures given at the École Normale, was followed by similar volumes—on divergent series, integral functions, meromorphic functions—all of great value to the students of analysis. The success of the series caused its scope to be broadened, and other writers contributed, under Borel's direction, notably Baire, Lindelöf and Lebesgue. The latter's two brilliant tracts, on integration and on trigonometrical series, showed for the first time to a wide public the full precision and power of the new theory of measure and of the new integral of Lebesgue. Borel never lost interest in the series of monographs; he constantly revised his own earlier volumes and prepared new ones, the latest appearing in 1952. This bore on the constructive definition and effective calculation of numbers, a topic on which he had always held strong views—strong enough at one time to carry him into a heated controversy with Lebesgue. To-day a mathematical library without the Borel monographs is unthinkable.

Shortly after the First World War, Borel, whose chair in the Faculty of Sciences at Paris was that of probability and mathematical physics, undertook the direction of another large co-operative enterprise, the famous "Traité du calcul des probabilités", in four volumes, each of five or six parts; and this itself was supplemented by a further series of monographs on probability, one of which was Borel's own work on the mathematical theory of bridge.

Borel's considerable powers of exposition were not confined to these two famous undertakings; his writings range from school geometry to relativity, all with a sureness of touch and an almost deceptive ease of manner. His triple claim to high rank in the hierarchy of mathematicians, as creative thinker, illuminating writer and powerful organizer, will cause his name long to be remembered.

T. A. A. BROADBENT

Dr. W. L. H. Duckworth

THE death, on February 14, of Dr. W. L. H. Duckworth, at the age of eighty-five, has removed from the Cambridge scene a scholar and a teacher of great distinction. Born in Liverpool in 1870, he was educated in Birkenhead and in France before going to Jesus College, Cambridge, in 1889. His associations with this College, of which he was elected a Fellow in 1893, were to be most intimate for the remainder of his long life, and culminated in his election to the mastership in 1940. At the age of seventy-five he retired from the mastership but continued to live in Jesus College until his final illness. He was president of the Anatomical Society during 1943–45.

Duckworth had very wide interests in anatomy, teratology, primatology, anthropology, archæology and general natural history. He commenced work in the Anatomy School under Alexander Macalister shortly after obtaining a double first in the Natural Sciences Tripos. This connexion with anatomy he maintained during his clinical studies at St. Bartholomew's Hospital, London, and in 1899 a University lectureship in Cambridge in physical anthropology was established for him. In 1919 he was elected to a readership in human anatomy—a post which he held until 1940. After his retirement he maintained his interest in the collections in the Anatomy School and, in spite of physical disability, did some College and University teaching well into his ninth decade. In his maturity Duckworth's formal teaching was most impressive; complete command of the facts, great blackboard artistry, an almost pedantic accuracy in description ("it is not so much a whorl as a convolution") and an eighteenth-century aristocratic manner combined to give a character to his lectures which was much appreciated by students of all levels of ability and assiduity.

During the early years of the century, Duckworth travelled widely on archæological and anthropological expeditions, and on visits to departments of anatomy on the Continent. At the same time he pursued the study of human skulls and of recent primates with a

complete devotion. Some of his many studies were summarized in his book "Morphology and Anthropology", published in 1904. This volume is still a mine of recorded facts on man and his closer relations, and it is a great pity that only the first volume of a second edition ever appeared. His work was highly individual in approach and presentation, and he inclined to put off publication in the hope that another specimen would turn up. As a result, much of his investigations was never published. His knowledge of the non-metrical features of the primate skull was unique, and his experience had given him a redoubtable sense of the appropriate in reconstructions. Consequently, he was always critical of the association of the Piltdown jaw with the cranium, and if he had been listened to in the earlier discussions on that material, several reputations in human palæontology might be a little less tarnished than they now are.

Duckworth was an insatiable collector with deep cultural and historical interests. A long life-time devoted to the gathering of material and the reading of all the related information in a number of languages gave him an impressive, almost an encyclopædic, knowledge. He was learned in half a dozen fields, and his long list of publications covers only a tithe of his life's work. He is already commemorated in Cambridge in the Laboratory of Physical Anthropology, which bears his name; this is most appropriate, for his prime interest was always the history of the human body. J. D. Boyd

Prof. S. F. Nadel

The Australian National University has suffered a great blow by the death in Canberra on January 14 of Prof. S. F. Nadel, professor of anthropology and dean of the Research School of Pacific Studies at the University. He leaves a widow and one daughter.

Siegfried Frederick Stephen Nadel was born in Vienna on April 24, 1903, the son of Dr. Maurice Nadel, a medical practitioner. Of Austrian nationality in his earlier years, he later became a naturalized British subject. He was educated first in Vienna, where he graduated D.Phil. in psychology. After a short period at Cambridge, he went with a Rockefeller fellowship to the University of London, where he took his Ph.D. in anthropology, studying under the late Prof. Bronislaw Malinowski at the London School of Economics. His first anthropological field-research was undertaken during the years 1934–37 in the Nupe Kingdom of Nigeria. From this work he published two books: "A Black Byzantium" (1942) and "Nupe Religion" (1954). The former has become a standard work in the West African field, and the latter is recognized as a very substantial contribution to the theory of primitive religion. As Government anthropologist in the Anglo-Egyptian Sudan during 1938–41, Nadel carried out research among the remote tribes of the Nuba Mountains. His book "The Nuba" (1947) is one of the most solid and extensive comparative studies in modern social anthropology; it examines the social institutions of ten different hill peoples.

During the Second World War, Nadel was appointed a political officer in Eritrea, and in 1945–46 he became deputy chief secretary in the British Military Administration in Tripolitania, with the rank of lieutenant-colonel. In 1946 he was awarded the Wellcome Medal for his anthropological writings based on his war-time experiences, and in 1950 he was given the Rivers Memorial Medal of the Royal Anthropological Institute for his field-research in Nigeria and the Sudan.

His rise in the academic field was rapid. He became lecturer in anthropology at the London School of Economics in 1946–47, reader in anthropology in the University of Durham 1948–50, and held the chair in anthropology at the Australian National University from 1950 until his death.

Nadel was one of the most significant figures in contemporary British social anthropology. His publications, which were numerous apart from his books, were noted for their theoretical stimulus as well as for the soundness of their ethnography. His general treatise, "The Foundations of Social Anthropology" (1951), was an attempt, on the whole successful, to explore the basic assumptions and methods of his science. It illustrated also his wide and informed interests in other social sciences and in philosophy. Only a week before his death he had completed a second general book, on the theory of social structure, based on lectures given in 1955 at the London School of Economics. This, too, is likely to become a standard work. Nadel was a fine scholar and a fine teacher. The Department of Anthropology and Sociology which he established and led at the Australian National University has already begun to make its mark through the quality of the work produced there. Raymond Firth

NEWS and VIEWS

Royal Society of Edinburgh: New Fellows

The following have been elected Fellows of the Royal Society of Edinburgh: Prof. D. H. R. Barton, regius professor of chemistry, University of Glasgow; Dr. J. Bell, senior lecturer in chemistry and assistant director of the chemical laboratories, University of Glasgow; the Hon. Lord Blades, senator of the College of Justice in Scotland and Lord of Session; Prof. J. H. F. Brotherston, professor of public health and social medicine, University of Edinburgh; Prof. G. M. Burnett, professor of chemistry, University of Aberdeen; Dr. J. G. Campbell, research officer (British Empire Cancer Campaign), Poultry Research Centre, Edinburgh; Dr. T. C. Carter, of the Institute of Animal Genetics, University of Edinburgh; Dr. C. B. Childs, senior lecturer in natural philosophy, University of Edinburgh; Prof. M. McG. Cooper, professor of agriculture, King's College, Newcastle upon Tyne, and dean of agriculture, University of Durham; Dr. H. K. Cowan, chief medical officer, Department of Health for Scotland; Prof. K. G. Denbigh, professor of chemical technology, University of Edinburgh; Dr. G. R. Evans, senior lecturer in natural philosophy, University of Edinburgh; Dr. D. T. Gibson, senior lecturer in charge of medical chemistry, University of Glasgow; Prof. W. G. Green, professor of mechanical engineering, Heriot-Watt College, Edinburgh; Prof. James Greig, professor of electrical engineering, King's College, University of London; Dr. D. C. Martin, assistant secretary, Royal Society of London; Dr. R. H. Millar, zoologist

at the Marine Station, Millport, of the Scottish Marine Biological Association; Prof. R. Miller, professor of geography, University of Glasgow; H. N. Munro, senior lecturer in biochemistry, University of Glasgow; Dr. A. Oppenheim, professor of mathematics, University of Malaya, Singapore; Dr. Magnus Pyke, head of the Laboratory Section, Yeast Research Organization of the Distillers' Co., Ltd., Menstrie, Clackmannanshire; Dr. W. Reid, member of the National Coal Board; G. A. Stewart, formerly assistant secretary and librarian, Royal Society of Edinburgh; Prof. T. Symington, St. Mungo-Notman professor of pathology, University of Glasgow; Prof. J. W. Watson, professor of geography, University of Edinburgh.

Awards

THE following Prizes have been awarded by the Society: *Keith Prize* for 1953–55, to Prof. A. D. Peacock (Queen's College, Dundee), for his paper in the Society's *Proceedings* during the period of the award and for his contributions to entomology and cytology; *Neill Prize* for 1953–55, to Dr. Robert Osborne (Poultry Research Centre, Edinburgh), for his papers in the *Proceedings* during the period of the award and for his contributions to knowledge of the genetics of the domestic fowl.

Aeronautical Engineering at Belfast: Prof. A. V. Stephens

PROF. A. V. STEPHENS, who at present holds the chair of aeronautics in the University of Sydney, has been appointed to the newly established chair of aeronautical engineering in The Queen's University of Belfast. This chair was established in 1955 with the aid of a generous grant from Messrs. Short Brothers and Harland. The Department is situated in the new engineering and science building, and it will be operating in January 1957. Prof. Stephens graduated in 1930 from St. John's College, Cambridge. After experience with the Royal Aircraft Establishment and as research fellow and demonstrator at Cambridge, he was appointed in 1940 to the chair of aeronautics in Sydney, and he has been dean of the Faculty of Engineering there since 1949. He has built up a flourishing department in Sydney and has played a prominent part in aeronautical research in Australia. He brings to his new post a wealth of experience both in the supervision of research and in administration. His appointment will notably strengthen engineering studies in Belfast and will create another valuable link between the University and the industry of Northern Ireland.

Zoology at the Chicago Natural History Museum: Dr. K. P. Schmidt

AFTER completing thirty years on the staff of the Chicago Natural History Museum, Dr. Karl Patterson Schmidt has retired from the post of chief curator of the Department of Zoology which he has held since 1941, and the latest volume of *Fieldiana* (37 (1955), from the Museum, 10 dollars) is very fittingly offered as a tribute to him. Dr. Schmidt has led a most active life both in the Museum and in the field. A prolific but nevertheless sound writer, he is widely known in North America not only for a most imposing series of scientific papers and reports mainly on material in the Museum, but also for some popular books. In fact, to English-speaking people as a whole, he is well known for his contributions to the "Encyclopædia Britannica", as translator, with W. C. Allee, of Hesse's "Tiergeographie auf oekologische Grundlage" and as part author of the "Principles of Animal Ecology". The last two owe much to his own wide field experience in five continents. Primarily a systematist, he has rendered useful service as editor of sections of *Biological Abstracts* ("Reptiles" since its foundation in 1927 and "Amphibia" added since 1941). Vol. 37 of *Fieldiana*, in its 728 pages, illustrated by 31 plates and 144 text figures, contains twenty-six articles covering a wide range of subjects, from a comparison of Old and New World Permian Reptiles to three new species of fleas from rodents, one named after Dr. Schmidt; from beetles parasitic on mammals to bats of the genus *Vampyrops*; from a discussion on the origin of the land birds of Tristan da Cunha to the ecology of fish in North Borneo. A point of interest in this great variety lies in the fact that, in a special note, twenty-seven of the authors admit their debt to Dr. Schmidt. The production of the volume is of the excellence one has learned to expect from the series. Dr. Schmidt has much work still in hand, and we wish him a happy and fruitful time in his retirement.

Meldola Medal for 1955 of the Society of Maccabæans

THE Meldola Medal of the Society of Maccabæans has been awarded for 1955 to Dr. Peter Gray, until recently of the Department of Chemical Engineering of the University of Cambridge and now lecturer in physical chemistry in the University of Leeds. The Medal is awarded each year, on the recommendation of a committee of the Royal Institute of Chemistry, to the chemist who, being a British subject and less than thirty years of age, is considered to have shown the greatest promise as indicated by his or her published work. After graduating in 1946 from the University of Cambridge, Dr. Gray began research in physical chemistry at Cambridge under Dr. F. P. Bowden, at first working on the growth and decay of the transient impulsive pressures developed during impact on liquids and the application of these results to the mechanical initiation of explosion. This was followed by a study of explosions in gaseous systems, in association with Dr. A. D. Yoffe, and led to the discovery in a number of simple decomposition reactions of cool flame phenomena, known previously only in combustion. In 1951 Dr. Gray joined the then recently established Department of Chemical Engineering in Cambridge, where his previous research on explosions developed into a study of flame propagation, particularly in chemically simple systems, which afforded crucial tests of theories of laminar flame propagation. Other fields investigated jointly in the Department were extensive work on the interpretation of the reactions of dinitrogen tetroxide; a study of the combustion of hydrazine; an investigation of the structure, reactivity and thermochemistry of the inorganic azides; and work on the thermochemistry and reactions of nitrites and nitrates.

Sir George Beilby Memorial Awards for 1955

THE administrators of the Sir George Beilby Memorial Fund, representing the Institute of Metals, the Royal Institute of Chemistry and the Society of Chemical Industry, have made awards from the Fund for 1955, each of one hundred and fifty guineas, to Dr. F. D. Richardson and Dr. F. Wormwell. The awards are made to British investigators for work in such fields as fuel economy, chemical engineering and

metallurgy, in which Sir George Beilby's special interests lay, and in general they are given to relatively young scientists for work over a period of years.

Dr. Richardson's award is for his work on the thermodynamic properties of high-temperature systems, with special reference to iron-smelting and steelmaking. After graduating in 1933 from University College, London, he did research there and at Princeton University and then joined the Royal Navy at the beginning of the Second World War. On demobilization in 1946 with the rank of commander, he joined the British Iron and Steel Research Association and worked on the thermodynamics of iron and steelmaking, extending his interests to the pyro-metallurgy of non-ferrous metals when he joined, in 1950, the Imperial College of Science and Technology, London, as Nuffield Fellow to establish the Nuffield Research Group in Extraction Metallurgy. The work of Dr. Richardson and his colleagues has covered solutions in iron, copper and lead and molten salts and silicates, especially the chemistry of sulphur dissolved in molten silicates as sulphide and sulphate. New measurements have been made of the activities in the iron–carbon system and of the influence of chromium on the activity coefficients of carbon and silicon in molten iron. These and other studies have been particularly important in elucidating the reaction equilibria of the blast furnace, in deoxidation and during carbide formation in cooling metal.

Dr. Wormwell, whose award is for his work on surface reactions, with special reference to the mechanism of metallic corrosion, oxidation and passivation processes, graduated in 1926 from the University of Manchester and has spent his research career to date at the Chemical Research Laboratory, Teddington, where he is now senior principal scientific officer and head of the Corrosion of Metals Group. Much of his earlier published work dealt with studies of the mechanism of metallic corrosion in salt solutions and natural water, with special reference to the influence of oxygen supply, temperature, pressure and movement, by means of accurate rate-measurements over long periods in carefully controlled conditions. He worked jointly on oxide films formed on mild steel and stainless steel at ordinary and elevated temperatures, and the development of improved methods of stripping films from the metal substrate. This has involved corrosion studies of moving specimens, high-speed-rotor and electrochemical tests of painted steel, cathodic protection, corrosion inhibitors (particularly sodium benzoate) and underground corrosion and its prevention.

Meteorology and Geographical Features of the Antarctic

The discovery by the United States Antarctic Expedition of a great trough flanked by mountains 12,000–15,000 ft. high in the Antarctic ice-cap between Victoria Land and Wilkes Land, reported by Dr. Paul Siple, of the Expedition, in *The Times* of March 6, if confirmed, will arouse particular interest in meteorological circles in Great Britain. The trough was reported as lying between a range of mountains roughly along the 160° E. meridian and another high mountain wall about 200–300 miles to the west. The floor of the trough was at 7,000–9,000 ft. above sea-level. The probable existence of such a mountainous channel in the lofty ice-covered interior of Antarctica in the sector indicated was predicted last year by Mr. H. H. Lamb, of the Meteorological Office, and Commander G. P. Britton jointly in a paper (*Geog. J.*, **349**; September 1955) quoting evidence of strong topographical effects on the atmospheric circulation in the Antarctic, and had previously been suggested in more general terms by Lamb (*Met. Mag.*, **111**; 1948). Peculiarities of wind flow are often explicable from the geography of the regions in which they occur, but this is believed to be the first time that the argument has been successfully used in reverse and meteorological evidence used to predict the discovery of a major geographical feature.

The meteorological evidence is also thought by Lamb (*Geog. J.*, **59**; 1948) to point to the existence of a mountain range or ice-cap crest of the order of 12,000–15,000 ft. or more in height in the heart of the hitherto unvisited region of 'East Antarctica'; the suggested approximate position and alignment were in the region about 80° S., 80° E., and parallel with the 140° E. meridian. There are indications also of low-lying regions in some parts of East Antarctica (W. Schmitt, *Notos*, **193**; Pretoria, 1952) sufficiently extensive for the accumulation of deep cold air masses which acquire significance in the general circulation of the atmosphere over the Southern Ocean. Meteorologists thus have a strong interest in the discovery of the main geographical features of the still unexplored parts of Antarctica.

New Out-station for the Atomic Energy Research Establishment

The Atomic Energy Authority is acquiring two built-up areas on Grove Airfield, near Wantage, as a site for a small out-station of the Atomic Energy Research Establishment, Harwell. These two areas are part of the airfield which the Air Ministry had decided to relinquish. The new out-station is mainly to provide laboratories to allow the Technological Irradiation Group to develop more rapidly. This Group, a part of the Harwell Isotope Division, was formed in June 1955 in order to assist industry in making full use of the large amounts of radioactive material which will become available from the expanding atomic energy programme. The additional laboratories at Grove are seven miles from Harwell and less than two miles from Wantage. In the choice of the new out-station preference was given to sites which had existing buildings so that the work of the new group could be advanced as rapidly as possible. The location of the Technological Irradiation Group at Grove, rather than at Harwell, will reduce the formalities for those who wish to use the irradiation facilities, and so make it easier for industry to co-operate to the full. No radioactive waste will be discharged, as any small quantities which may arise will be transferred to the main plant at Harwell for treatment and disposal. A similar system has been used by the Radiochemical Centre at Amersham, and has proved to be satisfactory in practice. Later it is proposed to transfer the Isotope School from Harwell to the new site on Grove Airfield.

Course of Nuclear Engineering at the University of Glasgow

An undergraduate course in nuclear engineering, primarily for final-year students in the mechanical and electrical branches of the Engineering Faculty, has been in operation at the University of Glasgow since the beginning of the present session. The course provides a general background of nuclear and reactor

physics for students who may later take up a specialized aspect of nuclear engineering; but as the subject becomes more firmly established further developments will be made, leading to the consideration in more detail of specialized topics. In addition to the university undergraduates, the course is being attended by a number of extra-mural students from local industry in Glasgow, and it is hoped and expected that this interest and participation will increase. Of the forty hours of lectures in the course, thirty are given by a member of the Natural Philosophy Department of the University, and the last ten by a member of the Engineering Department. The first few lectures are devoted to elementary atomic and nuclear physics, with emphasis on the energy bound in atoms, molecules and nuclei and on the possibilities of the release of this energy, and then the properties of neutrons and simple treatments of neutron thermalization are considered. This leads on to reactor physics, with calculation of the critical size of a homogeneous, graphite-moderated, pure uranium-235 reactor and simplified calculations for a heterogeneous reactor using natural uranium as fuel. A short account is given of the engineering problems caused by the fact that many materials have high cross-sections of thermal-neutron absorption. Further lectures deal with problems of irradiation, damage to reactor materials, health physics, radiation shielding, isotope separation, the breeding of nuclear fuel, and the uses of radioactive isotopes in industry. In the last ten lectures problems of heat transfer from the fuel elements to the coolants are discussed, together with the conversion of this heat energy into useful power. For the practical course, only ten two-hour periods are available, and the experiments are therefore simple, being designed either to demonstrate the orders of magnitudes of the relevant physical quantities or to illustrate points of nuclear engineering practice.

Technical College Libraries in Great Britain

A MEMORANDUM on libraries in colleges of technology and further education, which has been forwarded by the Council of the Library Association to the Scientific and Technical Information Committee of the Advisory Council on Scientific Policy, urges the need for a higher priority for college libraries in the expansion of technological and technical education and the allocation of more money for such libraries. Of the 555 institutions in Great Britain providing in some degree technical education, only 160 possess three hundred or more books housed in a room called a library, although this room is often used for other purposes and only is open as a library at specific times. 121 of these have some person other than a member of the teaching staff in charge, and altogether fifty-nine qualified librarians are employed in fifty-two libraries. The annual allowance for books, periodicals and equipment may vary from £50 to more than £2,000. Apart from meeting the needs of students and teaching staff for books and periodicals and providing an information service to assist students and staff in studies and research activities, a few of these libraries make useful contributions to the technical information service for industry; and the Library Association Council is convinced that the provision of adequate library services in technical colleges would make a valuable contribution to the dissemination of technical information and would also assist the training of qualified technologists.

For these reasons a statement of government policy regarding libraries for the various grades of technical colleges is urgently required to guide local education authorities and the Ministry of Education as to the development of existing libraries and the establishment of new ones. The Council also recommends that, in considering this development, due regard should be paid to co-ordinating the libraries with the services already provided by public, university and other libraries within the area served by the colleges, and all these libraries should be encouraged to co-operate in regional schemes for the provision of technical libraries, especially in subjects in which the college offers advanced courses. Special grants are needed to inaugurate and maintain libraries at a reasonable standard of efficiency, and the Council suggests that the 50 per cent subsidy on H.M. Stationery Office publications which is already enjoyed by public libraries and university colleges should be extended to all technical college libraries. National negotiation of salaries for qualified library staff by the appropriate Whitley Council is also recommended, as well as training in the use of libraries and books as part of the curriculum in all technical teacher-training colleges.

Ion-Exchange Resins for the Production of Pure Water

A LECTURE under the title "Will Ion Exchange replace the Laboratory Still?" was given to the Institute of Science Technology by Mr. W. F. Lorch (Elga Products, Ltd.) at King's College, London, on March 5. The considerable amount of power wastage in attempting to remove small amounts of impurities from large volumes of water was stressed. Ion-exchange resins, and the fact that most compounds ionize in water, gave the key to this problem. Three main methods of water treatment were outlined. The batch method, in which a quantity of mixed anion and cation resins is shaken with singly distilled water for one minute, is suitable for obtaining small amounts of very pure water. The two- or multi-column process requires flow through a cation and then an anion exchanger, or preferably a number of these in series since various equilibria are involved. Regeneration of the resins *in situ* necessitates the use of considerable quantities of rinse water. The single-column method uses a mixed bed of anion and cation resins, giving in effect a multi-stage process. With large-scale plants it is now possible to carry out regeneration *in situ*. The portable deionizer, which was demonstrated, is supplied with exchangeable cartridges of the mixed resins. Single-column exchangers can replace a distillation unit for most purposes. The cost of 'ion-exchange' water is in general much less than that of singly distilled water, while its conductivity is much lower. During the discussion it was mentioned that cartridges containing a dyed resin would soon be available, thereby enabling visual indication of exhaustion. The total solids obtained from an apparatus of this type is of the order of 2 p.p.m.

East African Agricultural and Fisheries Research Council: Report for 1954–55

THE East African Agricultural and Fisheries Research Council, which was established in 1954 as the governing body of the four East African Research Organizations, has issued its first annual report, covering the year 1954–55 (pp. 84; from the Librarian, Office of the Administrator, E.A. High

Commission, P.O. Box 601, Nairobi, Kenya; 1955; 3*s*.). Part 1 of the report gives a summarized account of the initial activities of the Council and the sequence of events leading to its formation. The details of its constitution and the Order approving its establishment are published as appendixes. Part 2 consists of reports from the four organizations themselves, namely, the East African Agriculture and Forestry, Veterinary, Fishery, and Marine Fisheries Research Organizations, respectively. They do not replace the annual scientific reports of these bodies, which will continue to be published separately. The aim is to give a general account in non-technical language of the individual problems, policies and achievements of the different organizations, and they certainly succeed in conveying the impression of well-planned research over a vast field. The agriculture and forestry report perhaps deserves special mention, for it reviews the work of the past seven and a half years, and in spite of the inevitable difficulties of a developmental phase, much has already been accomplished. The veterinary report provides an insight into the magnitude and variety of the problems confronting the livestock industry in East Africa, and the policy here will be to concentrate on relatively few, long-term and essentially East African problems. The establishment of the whole of this Organization at the new headquarters will simplify the necessary team-work. The fishery and marine fisheries reports are mainly concerned with fundamental investigations regarding the occurrence, life-cycles and feeding habits of freshwater and sea fish, together with complementary biological and hydrographic studies of their environment. Only on the basis of such knowledge can sound, economic fishery industries be built up.

Electronic Recording Machine for Financial Accounting

The October issue (7, No. 9; 1955) of *Research for Industry*, the news bulletin of the Stanford Research Institute, Menlo Park, Calif., is devoted to a description of ERMA (Electronic Recording Machine, Accounting) which has been developed in the Institute's Computer and Control Systems Laboratories for the Bank of America. The machine credits individual accounts with deposits, debits withdrawals, remembers details of all transactions, maintains correct balances, prevents overdrawing of accounts, and sorts cheques. The electronic bookkeeper has five input keyboards and two magnetic drums for recording up to thirty-two thousand accounts. Each cheque is identified by 'reading' information in coded-bars printed in magnetic ink on the back of the cheque. Detailed account information is stored on magnetic tapes, and monthly account statements are prepared from this information by a high-speed printer. ERMA contains 34,000 diodes and 8,000 other valves, weighs about 25 tons, uses 80 kW. of electricity and is cooled by an air-conditioning system. The first machine is to be moved to San Jose early this year to handle accounts in that area, and the Bank of America will need about thirty-seven machines to serve its branch banks in California.

New Permanent-Magnet Materials

Three new commercial permanent-magnet materials, which are modified forms of 'Columax' and are known respectively as 'Alcomax II *S.C.*', 'III *S.C.*' and 'IV *S.D.*', are now being made by member firms of the Permanent Magnet Association (301 Glossop Road, Sheffield 10). The performances of these new materials are intermediate between those of 'Alcomax' and 'Columax', although precise specifications are not given; the development of the crystal structure is limited to certain shapes and sizes, plain solid cylinders of diameter greater than 19 mm., with length somewhat less than the diameter, being most effective. The *B*—*H* curves show considerable improvement in remanent induction, coercivity and fullness factor over those of normal 'Alcomax III'. The new materials are likely to be particularly useful to manufacturers of loud-speakers.

Auxin Transport in Woody Shoots

Although the polar transport of natural auxin has now been confirmed for many herbaceous and woody species of plants, the rate at which it takes place has so far only been examined directly in the coleoptile of *Avena* and in the gynophore of *Arachis hypogaea*. F. G. Gregory and C. R. Hancock (*Ann. Bot.*, N.S., 19, 76, 451; 1955) have now described a method for the estimation of the rate of movement and the quantity transported of the natural growth hormone in standard isolated segments of apple shoots. During controlled storage, diffusible auxin is collected, and later by dividing the standard length of stem into small sections the location of the auxin front is determined, from which the rate of transport is deduced. Temperature markedly affects both rate of transport and amount of auxin transported, a maximum occurring at 27–30° C., followed by a rapid fall to zero. The total diffusible auxin in a given length of stem is not affected by storage temperatures below 30° C., but falls to zero at 42° C. The rate of transport and amount transported are proportional to the oxygen tension over the range 0–5 per cent oxygen, and there is some evidence for destruction of auxin in tensions below 2 per cent.

International Association of Agricultural Librarians and Documentalists: *Quarterly Bulletin*

The International Association of Agricultural Librarians and Documentalists was founded in 1955 to promote "internationally and nationally, agricultural library science and documentation, as well as the professional interests of agricultural librarians and documentalists". The interests of the members cover a wide field, as the term agriculture includes forestry, agricultural engineering, veterinary sciences, food and nutrition, etc. As a start, five working committees have been set up to deal, respectively, with the publication of a news bulletin, bibliography, professional problems, exchange of material and classification. The first number of the *Quarterly Bulletin* has now appeared, under the editorship of Mr. D. H. Boalch (Rothamsted Experimental Station, Harpenden), with the help of some twenty correspondents from various countries. It contains lists of new periodicals and reference books, and notices of forthcoming publications and congresses. Offers and requests for exchange and information regarding current professional literature naturally also find a place in a periodical of this type. The *Bulletin* is free to members of the Association only, the annual subscription for institutions, libraries, etc., being 50 Swiss francs or its equivalent, and for private individuals 10 francs. Inquiries regarding subscriptions should be addressed to the treasurer, Mr. T. P. Loosjes, Twentse Bank, Wageningen, Netherlands.

Low-Temperature Crystallography : Conference in Oxford

A CONFERENCE on low-temperature crystallography, organized jointly by the X-Ray Analysis Group of the Institute of Physics and the Low Temperature Group of the Physical Society, will be held in the Clarendon Laboratory, Oxford, during April 12–13. On the first day two sessions will be held on the following topics: physical problems in low-temperature crystallography (chairman, Dr. K. A. G. Mendelssohn), and X-ray methods and measurements at low temperatures (chairman, Prof. C. S. Barrett). The third, and last, session on April 13 will be devoted to a mixture of topics (chairman, H. P. Rooksby). On April 11, prior to the conference, the X-Ray Analysis Group will hold its annual general meeting, followed by a general discussion on the collection and classification of crystallographic data for determinative and reference purposes. The meetings are open to all interested, a fee of one guinea being charged to those who are not members of the Institute of Physics or the Physical Society. Registration forms and further information can be obtained from the Deputy Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1.

Discontinuance of the Physical Society's Reprint Scheme

DURING the past three years the Physical Society has run a reprint scheme whereby members and subscribers could purchase reprints of individual papers published in the Society's *Proceedings*. A survey conducted at the end of the three years has shown, however, that only about 5 per cent of the members have utilized the service and that the scheme has proved very costly, of the order of £600 a year compared with about £200 income from the sale of reprints. Accordingly, the Society has regretfully decided to discontinue the scheme as from the beginning of this year and the publication of Abstracts Bulletin No. 38.

Announcements

THE following elections have been made in the Paris Academy of Sciences: Prof. C. Bressou, director of the National Veterinary School of Alfort, to be a member of the Rural Economy Section in succession to the late Prof. M. Javillier; and Prof. F. van den Dungen, professor of analytical mechanics in the University of Brussels, to be *correspondant* for the Mechanics Section in succession to Prof. T. von Kármán, recently elected a foreign associate of the Academy.

THE Institution of British Agricultural Engineers is again offering two scholarships to candidates who are eligible for taking the final examination in 1957 for the National Diploma in Agricultural Engineering. The awards are the Farm Mechanization Scholarship (£100) of the Temple Press, Ltd., and the Dunlop Rubber Co., Ltd., Scholarship (£250), which is for a university graduate wishing to obtain the Diploma as a specialist qualification. Application forms, to be returned by May 1, and further information can be obtained from the Secretary of the Institution at 6 Buckingham Gate, London, S.W.1.

THE Society for Psychical Research is offering a prize of fifty pounds for an essay of less than 3,000 words on one of the following topics: (*a*) the best programme of research for the first one hundred hours of work with the next successful card-guessing subject discovered; the design should be supported by argument; (*b*) the best discussion of the logical and/or scientific implications of precognition, assuming this to be established statistically from the work of card-guessing subjects. Entries should be submitted under a pseudonym, and should be sent not later than October 1, 1956, to the Secretary, Society for Psychical Research, 31 Tavistock Square, London, W.C.1.

AWARDS are being offered from the Life Insurance Medical Research Fund of Australia and New Zealand, and as in previous years these will consist of grants-in-aid to non-profit institutions conducting medical research, fundamental or clinical, and research fellowships to medical graduates or those with equivalent scientific training for full-time research in problems broadly related to cardiovascular function and disease. The grants-in-aid are designed to cover all the financial requirements of a particular line of research and are usually £1,000–£3,000 a year for one to three years. The research fellowships may be taken up in Australia and New Zealand (£1,800–£2,000) for one year initially, or may be travelling fellowships for two years abroad and a third year in Australia or New Zealand (£2,000–£2,250 a year). Application forms for the awards, to be returned by July 1, and further information can be obtained from Dr. John H. Halliday, Medical Director, Life Insurance Medical Research Fund of Australia and New Zealand, 87 Pitt Street, Sydney, N.S.W.

THE Royal Society of Medicine, Section of Experimental Medicine and Therapeutics, is arranging a symposium on "Anti-tumour Agents", to be held in the rooms of the Society on May 7. Two groups of anti-tumour drugs will be discussed, namely, cytostatic agents (such as the nitrogen mustards) and antimetabolites, from the point of view of their physico-chemical properties, metabolic reactions and anti-tumour activity for both experimental and human cancers. Further information can be obtained from Dr. T. M. Chalmers, The Middlesex Hospital, London, W.1.

A SYMPOSIUM on "Corrosion Prevention in Packaging and Storage", organized by the Corrosion Group and the Birmingham and Midland Section of the Society of Chemical Industry, will be held during April 11–12 in the Chemistry Lecture Theatre of the University of Birmingham. Owing to the printing-trade dispute, it will be impossible to provide preprints of the papers; but summaries of all the papers and, where possible, complete copies of some of them will be sent to those registering for the symposium. Non-members of the Society can participate on payment of a fee of one guinea. Registration forms, to be returned by April 3, and further information can be obtained from the Assistant Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

BEGINNING this year, the *Physical Review* will no longer reprint the programmes and abstracts of papers contained in the *Bulletin of the American Physical Society*. The *Bulletin* will be published as a separate journal eight times a year and will appear previous to each meeting of the Society, so as to contain the detailed programme and abstracts of all papers to be presented at the meeting. Abstracts that appear in the *Bulletin* will not necessarily be published in the *Physical Review* or in the Society's other publications.

SOUTH AFRICAN COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR 1954

THE ninth annual report of the South African Council for Scientific and Industrial Research, covering the year ended October 4, 1954*, is, as usual, bilingual but now printed in double column. The research unit set up last year within the National Chemical Research Laboratory to deal with the needs of the Department of Nutrition has now been given independent status, and the number of major national laboratories directly controlled by the Council is now six. The Council's staff exceeds seven hundred, including 158 research scientists; but reference is made to the acute shortage of experienced scientists and engineers, particularly at the management-level, both in government technical departments and in industry. Postgraduate bursaries were awarded to sixty men and women during the year to enable them to extend their research experience, and also sixteen senior bursaries to research workers in universities and scientific institutions. An increasing proportion of the Council's operating expenses is now being met from funds other than Parliamentary appropriations, while, of the £90,000 now available annually to the five industrial research institutes subsidized by the Council, more than half is received from the industries concerned. Two new medical research units were formed during the year—for dental and for heart research, respectively, the latter being chiefly on investigation of myocardial infarction and coronary arteries. At the end of the report are a list of research bursaries and assistantships awarded during the year and also a list of publications by the Council and its staff or bursars.

In the National Chemical Research Laboratory, where a shortage of technical assistants in relation to research staff severely handicaps most divisions of the work and more experienced staff for process development is also needed, studies of South African clays have continued and further fundamental data were obtained on the electrode potentials of chromium and iron in acid solution in the presence of a mercury electrode. A fundamental study of the mechanism of autoxidation of branched-chain hydrocarbons has been initiated, and the conditions established under which pure 5-methylnonane autoxidizes without extensive gross degradation. The Laboratory is also examining the catalysts to be used in the Fischer–Tropsch process reactors and the products obtained with them. Considerable progress has been made in the desalting of brackish waters containing up to 10,000 p.p.m. of dissolved salts by electro-dialysis through ion-exchange membranes, and a pilot plant with a capacity of about 250 gallons per hour when desalting from 3,000 to 1,000 p.p.m. of sodium chloride has been operated day and night for several months to obtain design data for large-scale apparatus for gold mines in the Orange Free State to deal with brackish water. Problems involved in the purification of sewage effluents for re-use have again received priority, and operation of an experimental solar distillation unit has indicated that a unit of only 32 sq. ft. pan area is sufficient to supply drinking water for a normal household in places where only saline water is available.

Work on wool and marine oils has continued vigorously, and the optical configuration of wool wax and brain α-hydroxy acids was established by the synthesis of a series of Ls-α-hydroxy acids from Ls-malic acid. Continued study of sugar-cane cuticle wax has indicated that the main constituents are long-chain alcohols, and in view of the growing production of sisal in the Union the cuticular and wax coatings of the leaves of an *Agave* species have been studied. Fundamental structural studies are being made on the agar from *Gracilaria confervoides*; the mechanism of polymerization of certain natural fats has been further studied and the structure of methyl linoleate dimer investigated by a dehydrogenation-oxidation procedure. In the field of nutrition much attention is being given to the production of fish flour in a form suitable for enriching bread, and to its nutritional evaluation. Investigation of pentachlorophenol and other substances as inhibitors of corrosion of concrete by sulphuric acid - producing bacteria indicated that use of bactericidal cements is unlikely to prevent corrosion of concrete sewers in warm climates and that the solution must be sought in designing the sewer so as to prevent the build-up of hydrogen sulphide concentrations. The surface diffusion of adsorbed molecules has been further investigated and also the uptake of the systemic insecticide, OO′-diethyl *o*-ethylmercaptoethyl thiophosphate, from the point of view of its possible toxicity for human consumption.

The National Physical Laboratory is also experiencing difficulties in recruiting staff, particularly nuclear physicists and biophysicists, from abroad. Satisfactory progress is reported, however, with the erection of the cyclotron, which should have been complete by December 1955. Assistance is being rendered on an increasing scale to the Geological Unit of the Atomic Energy Board. A new method, based on an exchange reaction using radioactive iodine as tracer element, is being investigated for determining thyroid hormone in the blood, and the first phase of a study of hookworm infestation with iron-59 as tracer has been concluded. Progress is reported in the construction of a highly sensitive mass-spectrometer for the analysis of age of minerals with low uranium content, and electron-microscope observations on grain boundaries, sub-grain boundaries and slip traces on aluminium–copper alloys have provided direct evidence of the presence of dislocations. X-ray diffraction studies show that nickel, cobalt and zinc acetates have normal structures unrelated to those determined for cupric and chromous acetates. A curved crystal monochromator has been designed and built for the study of plastic deformation in metals, and a photometric method has been developed for the determination of sodium, potassium and calcium and also methods for determining the trace elements cobalt, molybdenum, zinc, lead, vanadium, chromium, nickel and sulphur. Further work has been done towards the establishment of primary temperature standards, and a new building for acoustic research completed and occupied. Electronic circuits for a

* South African Council for Scientific and Industrial Research, Ninth Annual Report, 1953–54. Pp. x+142. (From the Council, Pretoria, 1955.)

direct-reading spectrograph have been designed so as to eliminate the photographic plate and thus speed up spectrochemical analysis.

Considerable progress has been made in establishing facilities for research in mechanical engineering. An investigation on the influence of predeformation on the plastic properties of metals continued, and a fundamental investigation was commenced into the effect of interrupted loading and periodic overloading on the fatigue of metals. Considerable progress was made with the construction of apparatus for examining the use of South African coal as gas-turbine fuel and for the study of heat transfer between solid boundaries and fluids, while equipment has been designed for the study of heat transfer under condensing conditions. Facilities are also being developed for testing and calibrating instruments to measure accurately the low air-speeds which often prevail in ventilated spaces, and a study of fan design in relation to noise has been started.

The work of the Telecommunications Research Laboratory has included the measurement of radio noise-levels at 100 kc./s. with the view of assessing the effect of atmospheric radio noise on navigational aids, the study of the occurrence of precipitation static and corona effects in aircraft in flight, a survey of the effect of soil and terrain on the propagation of low-frequency radio waves in South Africa, and the study by radar of lightning discharges, while for the Department of Defence radar equipment specially suited to South African conditions is being developed. The National Building Research Institute has occupied its new Building Research Laboratory; although the move considerably interrupted laboratory work, fundamental work was carried out on foundations on expansive clay soils and on the behaviour of the hydration products of cement minerals in aggressive solutions; a brochure of house plans for the urban Bantu was prepared as well as a guide to the planning of Bantu primary schools and a paper of climatic data for use in the design of buildings in the Union.

The work of the National Institute for Personnel Research has been handicapped by a shortage of graduate staff and a labour turnover as high as 27 per cent. Considerable work continues to be done on personnel selection, although the work generally is now directed to the efficient use of personnel, including aptitude tests for native labour, field studies of the mentality of indigenous African peoples, and studies on the nature and measurement of personality and of the forensic and sociological implications of electroencephalography. Defence research included a study of methods of assessing flying proficiency and a new general screening and classification test for the Union Defence Forces. Besides collecting data on road accidents in a large passenger transport corporation, the Institute is investigating the causes of motor-cycle accidents.

The Leather Industries Research Institute records progress in its studies on the structure and molecular weight of wattle tannin fractions, the structure of the chromium complex, the theories of vegetable and chrome tannage, the physical properties of the globular proteins of hides and the shape characteristics of various South African groups of feet. Much of the work of the Fishing Industry Research Institute was again on a short-term basis, but it included attempts to discover a satisfactory objective test for freshness and to determine nutritional values and trace elements in marine products. The Sugar Milling Research Institute continued to study methods of juice clarification, and much attention was paid to the occurrence of starch in cane juice and in sugars. The Paint Industries Research Institute's examination of paint performance has indicated that the climate in Durban is exceptionally severe, and that the simpler kinds of finish do not give good results. The most notable achievement of the South African Wool Textile Research Institute has been the development of a theory of the origin of medium- and long-term irregularity in worsted yarn which permits detection of a machine that is not drawing properly and also forecasts the minimum number of drawing operations required to draw and spin a given wool top. The Bituminous Binder Research Unit has completed a preliminary investigation of photo-oxidation in the weathering of binders on the road and is attempting to establish the physical mechanism of binder failure under traffic. Medical research has included further work on the culture of amœba, the pathology of bilharziasis in experimental animals, the serological diagnosis of cercariæ, the use of the ballistocardiogram in assessing the functioning of the heart, studies in the nutrition of Bantu infants and young children, the macromolecular syndrome and the experimental physiology and metabolism of the baboon, physico-chemical studies on animal viruses, and studies on bacteriophage inhibitors and the isolation of viruses.

TECHNICAL CO-OPERATION SCHEME OF THE COLOMBO PLAN

IN June 1955 the Technical Co-operation Scheme of the Colombo Plan, the main purpose of which is to help member countries to raise the level of technical skills among agricultural, industrial and other workers, in co-operation with the technical assistance programmes of the United States and of the United Nations and its Specialized Agencies, completed its fifth year, and the report for 1954–55*, issued by the Council for Technical Co-operation in South and South-East Asia, records that all four main developments noted last year gathered momentum.

There was an increased flow of technical aid experts, trainees and equipment: 1,023 training places were provided in 1954–55, compared with 508 in 1953–54, bringing the total to 2,676, of which 440 were for training in agriculture, 428 in administration, 331 in engineering, 305 in education, 293 in medicine and health, 219 in industry and trade, 195 in transport and communications and 146 in power and fuel. Australia took 916 trainees, Great Britain 853, India 340, Canada 311 and New Zealand 226. The demand for experts, 129 of whom were provided in 1954–55 (compared with 86 in 1953–54), making a total of 392 against applications for 672, was heaviest in medicine and health (117), with transport and communications (54), engineering (51), food, agriculture and forestry (47), education (42) and industry and trade (27) following. Great Britain provided 157 experts, of whom 65 went to Ceylon, 64 to India and 23 to Pakistan; Australia 115 (35 to Malaya, 28 to Ceylon, 28 to Pakistan), Canada 59 (26 to Ceylon, 11 to Pakistan); New

* Colombo Plan. Technical Co-operation Scheme. Report for 1954–55 by the Council for Technical Co-operation in South and South-East Asia. (London: H.M.S.O., 1955.) 1s. 3d. net.

Zealand 44 (14 to Pakistan, 10 to Ceylon) and India 14 (10 to Ceylon, 4 to Indonesia). Posts of professors at universities and technical institutes remain hard to fill, and recruitment of some types of engineers and technicians is difficult. More inquiries are being made about the availability of firms of consultants. As regards equipment, the trend is towards equipment for establishing or expanding training and research facilities in the region with the object of training instructors. Equipment has already been supplied, ordered or offered to the value of £1·5 million against requests for more than £2 million, including £344,000 worth of laboratory equipment for research, £927,000 of training equipment and £97,000 of equipment for food and agriculture, most of this coming from Great Britain.

The movement to create or expand and improve training centres in South and South-East Asia continued. Among many examples given in the report are the assignment by Great Britain of four medical scientists to help the new medical colleges established by the Government of India by lecturing and demonstrating for ten weeks in India new techniques in diagnosis and treatment; the library facilities given by Australia and New Zealand to the University of Malaya, Singapore; the supply to Pakistan by Britain of equipment, an engineer and three demonstrator instructors to assist the change-over from manual control to automatic telecommunications; and the training of twenty-two teachers to help organize and administer technical high schools being established by the Pakistan Government.

Mutual aid in the region also made some further progress, and greater use continues to be made of technical assistance to promote economic development and raise the standard of living. Among new projects in this field the emphasis has now shifted from measures to avoid loss from pests, weeds and disease to measures to preserve food. Australia is giving equipment to the Dairy Research Institute, Bangalore, and is also arranging a tour for milk commissioners from Bombay and West Bengal and the head of the Dairy Technology Division of the Indian Dairy Research Institute to observe the large-scale handling and manufacture of milk and milk products. The Ceylon Government is taking steps to establish a rice research organization to help the drive towards self-sufficiency in rice, and Japan is sending two leading rice physiologists to study conditions in the main rice-growing areas and submit a detailed scheme for the proposed research organization. Britain has assigned an expert to the Indian Central Cotton Committee to review cotton research at the Institute of Plant Industry, Indore, and is supplying equipment to the newly established Pakistani Institute of Cotton Research and Technology at Karachi. Under the Colombo Plan agriculture is being promoted, along with industry, by irrigation and power projects, while output is being increased by the improvement of transport and communications. Britain, for example, is training the assistant director of soils for the Central Road Research Institute, Delhi, and has sent the Deputy Chief Engineer of the B.B.C. to review installation work already carried out by Radio Pakistan and to advise on the technical aspects of the future development plans; it has also assisted the Indian Central Glass and Ceramic Institute and the Central Leather Research Institute with technical facilities. Australia is providing research equipment for the brick and tile industry of Ceylon and is training a Pakistani officer who is to be employed on wool research testing, as well as five sugar technologists for Pakistan's new sugar factories.

While more trainees were sent abroad under the Scheme in 1954–55 than in any previous year, the training was also more closely fitted to the needs of the development projects. Under the Colombo Plan, including United States assistance, the countries of the area have now sent abroad 5,701 trainees and received 1,341 experts, mostly from outside the region; with the United Nations figures, the totals are 7,159 trainees and 3,741 experts. A large measure of co-operation has now been achieved, and the co-operating governments have a better idea of what forms of assistance the respective agencies can best provide.

MAN-POWER IN THE BRITISH COAL INDUSTRY

In a lecture to the Royal Institution of Public Administration on November 28, 1955, Mr. A. H. A. Wynn, scientific member of the National Coal Board, discussed the momentum of decline of the coal industry, which continued in spite of any increase in demand. Behind a fall in production from 287 million tons in 1913 to 174 million tons in 1945, the industry's ability to produce has also fallen. Mr. Wynn did not discuss many of the factors contributing to this momentum of decline, but pointed out that because of the gradual exhaustion of reserves in each individual mine, the productive capacity of the coal industry must decline by two or three per cent each year, if there is no large-scale reconstruction and no new collieries are opened. This decline affects adversely the standards of the industry's technology, its staff structure, its world reputation and its ability to recruit staff. Mr. Wynn did not discuss these imponderable psychological and educational problems, however, but rather the creation and growth of special administrative structures, some of which would be the responsibility of scientists and engineers. These organizations, he thought, are the most hopeful means of reversing the decline. He suggested that they fall under four headings: exploration, or the survey of natural resources; capital investment; the improvement of methods of production, primarily by promoting technological progress; and research and development, directed to increasing the commercial value of the industry's products. All are closely related; but only the first is peculiar to an extractive industry, and the inadequacy of our knowledge of coal resources is a factor in the momentum of decline that has delayed the reconstruction of the industry. The Board has also had to establish from slender resources the Planning Branch of the Production Department responsible for the large-scale reconstruction of old mines and the development of new ones, and its task has been made more difficult by the scarcity of suitable staff and the urgent demands for more coal.

Before 1947, the resources of the industry of Britain for promoting technological development were few; but the industry was profoundly dependent on heavy labour. A Mechanization Branch of the Production Department was established in 1947, supported by an Engineering Branch, and recently the Board has established a Central Engineering Establishment, near Burton-upon-Trent, for pursuing

the development of new machines and providing guidance to manufacturers; and a Mining Research Establishment was set up at Isleworth in 1952. The Safety in Mines Research Establishment of the Ministry of Fuel and Power is still the largest mining research establishment in Britain, and the National Coal Board has inherited very few men experienced in mining research. In the post-war man-power situation, the Board has found difficulty in recruiting the scientific and technical staff it needs, and this is the main limit on the Board's expansion plans. Mr. Wynn emphasized that production depends on the outcome of a race between increased mechanization and falling man-power in the mines. Two other organizations, however, have also been established which can do much to improve productivity. The Scientific Department has established a Field Investigation Group, analogous to the operational research teams of the Service departments, and the Production Department has set up a Method Study Branch. These establishments are in close touch and will play a big part in reducing man-power requirements.

SOCIAL PROBLEMS OF INDUSTRIAL DEMOCRACY

THE Department of Social Science, University of Liverpool, has published, as Occasional Papers No. 2, "Industrial Democracy: a Revaluation", by W. H. Scott (pp. 40. Liverpool: University Press, 1955; 3*s*. 6*d*.). This essay is intended to meet the needs of industrialists, trade unionists and others who wish to acquaint themselves rapidly with some of the broad conclusions resulting from systematic research and current thought on this topic. It is limited, however, primarily to problems arising at the factory- or plant-level and is essentially a stock-taking. Industrial democracy is regarded as implying the participation, to a greater or lesser extent, of those who work in industry in determining the conditions of their working lives. The review answers the question, "Is industrial democracy desirable?" with an emphatic affirmative, and Mr. Scott also believes that industrial development has justified our faith in the efficacy of democracy to check the arbitrary use of power.

While an extension of the democratic principle at the formal policy-making level of a firm is important, its application in day-to-day executive leadership is equally vital, and these two processes are inter-dependent. Mr. Scott makes some constructive comments here, and on the position of the trade unions, which are of especial interest at the moment. He notes the need to develop "consultative leadership" as part of the administrative routines of a firm at every level, as an essential concomitant to more effective formal procedures at the policy-making level, pointing out that higher management must take and maintain the initiative in both these respects. He also directs attention to the presupposed attitudes of leadership and administrative ability and to the implications in respect of selection and training for such posts. Similar considerations apply to the trade unions, and if the excessively bureaucratic tendencies of some unions are to be checked, and a balance achieved between the need for a measure of centralized administration and the desirability of developing local initiative and responsibility, then similar criteria must be applied to the selection and training of full-time trade-union officials.

Just as the effective working of any new procedures within the firm calls for a capacity for consultative leadership on the part of managers, so the delegation of greater responsibility to lay-representatives by the unions, which is so essential to industrial democracy, requires appropriate attitudes on the part of officials if it is to be used creatively. Moreover, industry does not exist *in vacuo*, and Mr. Scott points out that to achieve stable and enduring changes in industry, we must also concern ourselves with developments in other institutions of our society and particularly those which are basic and most formative of personality.

FIBRE MICROSCOPY

A WELL-ATTENDED symposium and exhibition organized by the Industrial Section of the Royal Microscopical Society was held at the British Pharmaceutical Society in London on November 16, three sessions of papers being given in the lecture theatre, while an exhibition was staged in the hall. Opening the first session of papers, Dr. R. C. Faust discussed the use of the interference microscope in the examination of fibres. The degree of molecular orientation and closeness of molecular packing at different regions of an anisotropic fibre have been studied by means of multiple-beam interference with the conventional microscope and by means of two-beam interference with the Baker interference microscope. Mr. D. S. Gowers then described the study, by interferometric methods, of the adhesion between fibres. When an artificial point of contact between a fibre and a quartz plate is examined by incident illumination, Fizeau fringes give a contour map of the fibre surface. The area of contact can be determined by the intensity distribution across the central dark spot. The effect of humidity, temperature and contaminants in the fibre was discussed.

The first two papers in the second session were devoted to the methods of producing replicas for use in the electron microscope. With textile fibres it is the surface that is of main interest, and this may be studied by means of replicas of the fibres, examined under the reflexion electron microscope. The curvature of the fibre presents an added difficulty in obtaining a successful replica, and Dr. J. Dlugosz described the various methods of replication investigated to obtain a successful routine method.

A method of producing solid metal replicas of fibres, for use in the reflexion electron microscope, was then described by D. E. Bradley, who discussed the advantages of this method over that of direct examination, and Dr. K. Little considered the use of the electron microscope in conjunction with other techniques, such as X-ray diffraction, histology and chemical investigations, in the study of fibres in human connective tissues. Each method of microscopy has its advantages and its limitations. H. W. Emerton's paper, read by D. H. Page, described how, by using three methods—namely, light microscopy, reflexion electron microscopy and transmission electron microscopy—in the study of natural fibres, a more complete picture can be obtained. By means of a plastic metal replica, the same fibre can be examined by all three methods.

The third session was opened by Dr. A. E. J. Vickers with a short historical survey of the pro-

duction of quartz fibres, accompanied by a demonstration. Their physical properties, and their recent use in optics for the rapid transmission of images, were discussed. H. M. Appleyard described how the causes of faults in textiles, many of which are not obvious until the fabric has been dyed and finished, can be ascertained by microscopical examination. Faults may be due to adulterant fibre in the blend or to solid matter attached to the fibres, such as pieces of skin. Identification tests include normal histological techniques or microchemical tests followed by examination under the conventional or phase-contrast microscope. The systematic study of the removal, from a variety of textile fibres, of compounds of the same type as those found in fatty dirt from worn garments was described by R. E. Wagg. He discussed the action of several different classes of detergent, builders and other additives.

The measurement of the diameter of glass fibres, either mechanically drawn or steam-blown fibres, can be carried out by means of a projection microscope, and A. Pimblett described this method, together with the techniques required to prepare mounts of cross-sections of fibres. By this method of viewing, variations in diameter and cross-sectional shape, and the bonding together of steam-blown fibres to form insulation products, are revealed. The appearance and handle of acetate fabrics are profoundly affected by the cross-sectional shape and surface of the filament. These characteristics require to remain constant in a given spinning run, and L. Krause described how, as a method of control, yarns are examined microscopically for lustre and cross-sectional shape.

At the exhibition held in conjunction with the symposium, D. E. Bradley showed electron-micrographs of various fibres examined under the reflexion microscope by means of replicas. Faults causing electrical failure in thin oriented polystyrene-film capacitors have been identified microscopically as particles of dandruff introduced by the machine operators, and H. F. Church exhibited several of these faults, together with photomicrographs illustrating their structure. Dr. M. Dempsey and Miss B. M. Haines demonstrated a melting-point apparatus, adapted for measuring microscopically the shrinkage temperature of isolated leather fibres, and H. W. Emerton, J. Watts and D. H. Page showed photo- and electron-micrographs of various paper-making fibres.

The penetration and distribution of stain in a damaged rayon fibre can determine the type of damage, and Dr. D. G. Drummond and J. E. Ford exhibited photomicrographs illustrating the different types of fibre damage. Electron-micrographs of the surface of textile fibres made by the replica technique in the transmission electron microscope were also shown. Photographs of apparatus and of Fizeau fringes around points of contact between fibres and a quartz plate were shown by D. B. Gowers, while C. F. Griffiths exhibited specimens and photomicrographs of glass fibres containing crystalline inclusions; the inclusions may originate from the raw materials, or the refractories of the furnace or devitrification of the glass itself, and they can be identified by means of the polarizing microscope or by the X-ray diffraction method.

Photomicrographs illustrating the differences between textile fibres of vegetable origin were contributed by C. J. Jarman; from the size of the cell and the number of cells to a fibre it is possible to identify the fibre. Photo- and electron-micrographs of the fibres in human connective tissues were shown by Dr. K. Little, and J. A. Mason displayed samples of 'Perspex' and polythene that had been used for insulations and were exhibiting erosion and breakdown in the form of dendritic channels formed by local stress and heating by electrical discharges. T. S. Millen and R. S. Page demonstrated the use of the electron microscope for the examination of the surface of fibres by the reflexion method.

Slides and photomicrographs were used by A. Pimblett for demonstrating the method of measuring the diameter of glass fibres, and Dr. F. Stern showed photomicrographs and X-ray diffraction patterns of coir fibre, demonstrating the special fibrillar orientation of the cellulose microfibrils. Quartz fibres and photographs illustrating the methods for producing the fibres were exhibited by Dr. A. E. J. Vickers, and R. E. Wagg and Miss Gayner Stephens showed by means of photomicrographs the effect of various detergents on fatty dirt contaminating textile fibres. C. R. Watts contributed photomicrographs illustrating various yarns and fabrics, including modern developments in bonded and coated fibres; some common faults and their causes were also shown.

Electron micrographs and stereomicrographs showing the surface characteristics and microfibrillar texture of keratin fibres were exhibited by Mr. H. J. Woods and Dr. J. Sikorski. Miss E. Frei and Prof. R. D. Preston exhibited longitudinal and transverse sections of coniferous woods 300 A. thick for study in the electron microscope; the electron-micrographs showed the fine spiral structure of the various layers of the wall.

RHEOLOGY OF PROTEINS

A SYMPOSIUM on the "Rheology of Proteins" was held in London on January 20 by the British Society of Rheology. Four papers were presented, each of which aroused considerable discussion. The chairman, Mr. A. G. Ward (British Gelatine and Glue Research Association), in his opening remarks, outlined the wide scope covered by the title of the symposium. Proteins, the mechanical properties of which play a vital part in their functioning in living organisms, include serum proteins, epidermal and connective tissue proteins, muscle proteins, many cellular proteins, mucoproteins and mucopolysaccharides, etc. The rheological properties of certain of these also contribute to their subsequent use in meat, egg and other protein foods, in protein fibres, in gelatin and animal glue, and in other products. In the background, for all these substances, rest the two common problems of the covalently bonded structure of the protein molecules and the secondary forces—ionic, hydrogen bonding, and van der Waals interactions—which link the molecules together to form macroscopic aggregates. Only by isolating the simplest systems will it be possible to solve the many complex problems.

Dr. E. J. Ambrose (Chester Beatty Research Institute), in his paper on the formation of structure in protein solutions, was concerned with the conditions in which a two-phase system can be formed, the protein or related component being organized or ordered in the concentrated phase. The properties of a macromolecule determining its tendency to form such structures are particle size and flexibility, the

latter influencing the disturbance by Brownian movement, shape, the interaction forces, and the degree of reversibility of the changes. If the interaction forces are strong, there is a greater tendency to a disordered separation of the second phase, whereas weak forces suffice to make the necessary links only when a degree of order is attained. These considerations were illustrated by the structures obtainable with *poly*-γ-benzyl-L-glutamate in chloroform solution, and with insulin. Birefringent structures show orientation to be occurring when phase separation occurs.

Primary interest is on the behaviour of the cell nucleus and its component nucleo-proteins. Whereas nucleic acid alone fails to give phase separation, nucleoprotein forms fibrous structures, showing birefringence and dichroism. The existence of different structures at different concentrations for nucleo-proteins is shown by a discontinuity in the relation between concentration and diffusion constants. No discontinuity is observed for the nucleic acid alone. The techniques and theories have been applied to the structure of chromosomes and also to the formation of the tail of the sperm during meiotic division.

In the second paper, Dr. A. Wassermann (University College, London) described his work on a viscosimetric investigation into the influence of *p*H and ionic strength on molecular shape of a structural muscle protein. Two views have been put forward concerning the actomyosin molecule, the first regarding it as a stiff rod or elongated ellipsoid of revolution and the second treating it as a flexible random coil. Use of the mixed-bed ion-exchange resin column enables actomyosin solution of very low salt content to be prepared. Alkali additions give solutions, the 'intrinsic viscosities' of which extrapolated to zero rate of shear, and to zero concentration, are a maximum in the region of *p*H 8–9. At higher *p*H, lower values are obtained. No peak is observed on the acid side. The absence of change below *p*H 4 is assumed to arise from anion binding neutralizing the charges developed. The peak is considered to arise from the stretching out of the molecule by the repulsion of negative charges present at the *p*H's concerned. Beyond a certain *p*H the concentration of counter ions becomes sufficient to reduce the forces between the charges, so that a reduction in 'intrinsic viscosity' occurs; similarly, the addition of neutral salt in sufficient amount reduces the changes in intrinsic viscosity to zero. All these observations are fully compatible with the random coil hypothesis but are inconsistent with the stiff rod theory.

In the third paper at the symposium, on some rubber-like and relaxation properties of gelatin, Mr. D. W. Jopling (Kodak, Ltd.) demonstrated that gelatin films maintained at a water content of 25–30 per cent by immersion in 85/15 alcohol/water or by exposure to high humidity show rubber-like extensibilities of up to several hundred per cent. This is best shown when the ordered arrangement, brought about by drying, has been destroyed by immersion in boiling methanol.

By cross-linking gelatin molecules with formaldehyde, measurements on the resultant film can be carried out at temperatures at which normal gelling forces are absent, for example, 60° C. Stress relaxation then follows the Maxwell relation log (stress) = $A - B$ (time), whereas at room temperature stress is proportional to log (time). It is assumed that at 25° C. the mechanism is primarily the release of secondary bonds, with a wide spectrum of relaxation times, whereas at 60° C. only primary bonds are broken. At 40° C. both processes can be observed to occur in succession. The form of the extension–tensile stress relation for gelatin cross-linked with formaldehyde at 60° C. follows the theoretical curve for an ideal rubber-like system up to extension ratios of 4 : 1. The values for the chain molecular weight between cross-links deduced from the theory appear high; the reasons for this are not clear.

The final paper, by Dr. J. Brooks and Mr. H. P. Hale (Low Temperature Research Station), on the mechanical properties of the ovomucin gel of the egg, was given by Dr. Brooks. The thick white fraction of the hen's egg consists of a gel in which a transparent phase is separated by a series of parallel bands of microscopic fibres. After the egg is laid, the volume of thick white decreases at a rate depending on the temperature. The mechanical properties of the gel have been investigated by a method originally devised by Freundlich, in which the displacement of a minute nickel particle inserted in the gel is measured microscopically. The force is applied by means of a magnetic field. For stresses of short duration, the displacements are elastic in character in both the transparent phase and the bands. The bands are anisotropic. The relative values of the rigidities are converted into absolute units by means of a series of measurements on gelatin gels. Measurements have been made on fresh eggs and on eggs stored at 25° and 0° C., and it has been found that there is a close relation between the rigidity of the thick white fraction and its volume, irrespective of the reason for the volume difference.

A. G. WARD

SOME RECENT DEVELOPMENTS IN MAGNETISM

THE Electronics Group of the Institute of Physics held an informal symposium in London during September 23–24 on "Some Recent Developments in Magnetism", at which seven papers were read and discussed. The first speaker, Dr. E. W. Gorter (Philips Laboratories, Eindhoven), outlined the theory of the magnetic properties of the ferrite group of materials. They have the spinel type of structure, in which the metal ions occupy two different types of site, and the interactions between the ions are such that the total magnetic moment is roughly equal to the difference between those for the ions in the two types of site. Dr. Gorter showed why this relation might not be exact, and how various anomalous shapes of saturation/temperature curve can occur; he demonstrated a striking example, namely, a material the spontaneous magnetization of which is reversed as the temperature rises. The properties of ferrites can be used to infer the relative strengths of the interactions between ions in various configurations, and the evidence so obtained supports the theory of super-exchange.

Ferrites are insulators, some of them having resistivities of the order of 10^5 ohms, and can therefore be studied in fields alternating even at microwave frequencies, whereas any similar experiments with metals are largely prevented by the effects of eddy currents. J. Watkins (G.E.C. Research Laboratories, Wembley) described the Faraday rotation and the transverse phase-shift, two effects observed in such experiments. The latter effect is a variation

in phase and attenuation for the two directions of propagation, observed when a magnetic material in a waveguide is subjected to a transverse magnetic field. The Faraday effect, observed when there is a static magnetic field along the direction of propagation, is non-reciprocal—that is, waves travelling either with or against the direction of the static field have their planes of polarization rotated in the same direction in space.

B. G. Parkin (Post Office Research Station, Dollis Hill) discussed the properties required in the magnetic cores used for the 'memory' circuits of computers and similar apparatus. These cores should have nearly rectangular hysteresis loops and must be capable of reversing their magnetization in a few microseconds in a field of about 1 oersted. The time required for reversal is governed not only by the decay of eddy currents but also by the damping of changes of alignment of electron spins. The operating conditions can be met both with ferrites and with metal tapes a few microns thick. A rectangular loop in metals may be produced by grain orientation as the result of severe cold-rolling, or by annealing in a magnetic field. In the discussion, Dr. Gorter explained the rectangular loops of ferrites as the result of one source of anisotropy outweighing all others.

Dr. R. Street described the experimental methods developed at the University of Sheffield for the measurement of spontaneous magnetization. In the interesting range near the Curie point, the magnetization is markedly dependent on field, and the problem is to find methods which allow extrapolation to zero field. There are two main techniques available: the measurement of mechanical force in a non-uniform field, and the measurement of temperature rise on the removal of an applied field. The use of photo-electric amplifiers with galvanometers has so increased the sensitivity attainable by the second method that results obtained by the two methods can now be compared. The approximations made in deducing Curie temperatures are such that the methods lead to values differing by, for example, 4 deg. C., but the existence of anomalous shapes of saturation/temperature curves has been established beyond question.

Particles of iron, if small enough, are known to be magnetized as single domains and therefore to have very high values of coercivity. This coercivity depends on the shape of the particles, being high if they are acicular, and is also high if the anisotropy of the material is large, as in manganese bismuthide or in cobalt. Dr. E. P. Wohlfarth (Imperial College of Science and Technology, London) indicated the types of formula that have been calculated for the effect of interactions between particles in an aggregate, and for several possible distributions of particle shapes. This work has applications not only to the manufacture of permanent magnets and magnetic recording tapes, but also to the study of rock magnetism. He is now extending the theory to the properties of particles which are large enough to contain a single domain-wall.

Dr. N. C. Tombs (G.E.C. Research Laboratories, Wembley) described experiments to produce iron powders showing the properties of a permanent magnet. For practical purposes, a coercivity of about 200 oersteds is needed, which cannot be obtained with spherical particles. Particles of hydrated alpha-ferric oxide are known to have acicular shapes, and with the help of a series of electron micrographs Dr. Tombs was able to demonstrate this property on a number of these powders prepared under laboratory conditions. X-ray analysis confirmed that the particles seen in the electron micrographs were in fact single crystals. If such powders could be reduced in a stream of dry hydrogen under carefully controlled conditions, without their shape and size being altered, then the resulting iron powder should exhibit useful magnetic properties. A further series of electron micrographs showed that during the reduction much of the acicularity of the particles was lost. Sufficient remained, however, to give a useful coercivity even after compacting. Although the $(BH)_{max.}$ product was much lower than the corresponding figure for barium ferrite, the ratio of B to H is so different in the two materials that each may be useful in particular applications.

Dr. G. E. Bacon (Atomic Energy Research Establishment) reviewed the rapidly expanding field of neutron-diffraction studies of magnetism. Elastic scattering of neutrons from either ferromagnetic or antiferromagnetic substances gives regular diffracted beams which are superposed on the ordinary scattering, and from which the order of the atomic magnetic moments can be inferred (though not without ambiguity unless the specimen is a single crystal). The evidence so obtained supports Néel's theory of ferrimagnetism in ferrites, and neutron diffraction is the main source of evidence for antiferromagnetism. Ordered forms of alloys such as Ni_3Fe have been detected. Inelastic scattering also occurs; in magnetic materials it disturbs the atomic magnetic moments and causes further inelastic scattering by which the disturbance can be detected. The most serious experimental difficulty is the weakness of the available 'monochromatic' beams of neutrons, the intensity of the beams used for X-ray diffraction being about 10^6 times as great. There is great scope for further experimental work, but much of it must necessarily wait until powerful sources of neutrons are more widely available in research establishments.

Each of these seven papers was followed by questions and discussion, and Dr. Gorter's contributions should be mentioned as being particularly helpful.

A. C. Lynch
J. Watkins

DAILY MAPS OF THE SUN

In the study of solar–terrestrial relationships, obtaining solar data of a homogeneous nature over a period of years or of decades is one of the principal difficulties. Where daily observations of the Sun are required, co-operation between a number of observatories is essential if there are to be only a small number of unrepresented days. The difficulty then arises of obtaining uniform quality of original material from the different contributing observatories. Although suitable means of doing this have been available for many years in the case of solar photographs in integrated light, similar co-operation with instruments showing the features only visible in monochromatic light has in the past been hindered by difficulties in reaching agreement on the precise instrumental requirements, in maintaining the observing routine and standard of quality, and in providing suitable means for reduction and publication of material. A fresh attempt at co-operation between a number of observatories has now been

started by the Fraunhofer Institut, of Freiburg-im-Breisgau, Germany, for the purpose of producing daily maps of the Sun showing photospheric and chromospheric details and coronal intensities for λ 5303.

Among the observatories contributing chromospheric data are those of Freiburg, Kodaikanal, Wendelstein, Tokyo and Sydney. The coronal data are provided from the observatories of Climax, Sacramento Peak, Pic du Midi, Kanzelhöhe and Wendelstein. Istanbul, Potsdam, Arcetri and the German and Swedish stations on Capri also contribute material. The reduction of data and production of the daily maps are carried out at Freiburg and the printing is by a half-tone process to a scale of 15 cm. to the solar diameter. Conventions are used to show the areas occupied by calcium *plages* of low, intermediate and high intensity, and the shapes of dark filaments and limb prominences are shown, all against a background of lines giving heliographic co-ordinates. Limb coronal intensities and the positions and Zurich types of the sunspot groups are shown schematically. The aim is to produce these maps at intervals of two weeks with a delay of two weeks from the date of the latest map. Only a small number of gaps are expected to occur throughout the year.

These maps will provide a series for reference which with regard to the chromosphere should be more valuable than all other similar information published elsewhere. It remains to be seen how well the standards of indicating the various phenomena fluctuate from day to day and deviate from the initial standards over long periods of time. The possibility of such variations must be kept in mind when investigating solar – terrestrial relations, and it would be interesting to know if any special safeguards have been adopted in the present instance, where quantitative assessment apparently takes no part in the stages prior to publication. It certainly seems possible to draw quantitative information from these maps in a satisfactory manner; but it is the responsibility of the person who uses the information to make sure that it is inherently suitable for his purpose. Only the considerable task of collecting the raw material and making it available has been taken for him.

P. A. Wayman

B.B.C. ENGINEERING MONOGRAPHS

THE *B.B.C. Quarterly*, which has been issued since April 1946, ceased publication in the autumn of 1954, and in order to provide a vehicle for the publication of technical papers of the type hitherto included in this journal, the British Broadcasting Corporation has recently issued the first four of a series of "B.B.C. Engineering Monographs", about six of which will be produced every year (annual subscription £1); each monograph will deal with a technical subject within the field of television and sound broadcasting and will describe work that has been done by the Engineering Division of the Corporation, including, where appropriate, a survey of earlier work on the same subject. The series will also contain, from time to time, selected reprints of articles by B.B.C. authors that have been published in technical journals.

The first monograph, "The Suppressed Frame System of Telerecording", by C. B. B. Wood, A. V. Lord, E. R. Rout and R. F. Vigurs, summarizes the fundamental and practical aspects of a telerecording system using standard 35 mm. film. The recording cycle consists of exposure during one whole television frame while the film is stationary in the gate, followed by pulldown of the film during the next, or suppressed, television frame. Thus the picture photographed on the film corresponds to a 202½ line structure; but with the use of spot-wobble to broaden the lines, the recording is found to give an acceptable picture when the film is re-scanned by the standard 405 lines in the teleciné machine. Three photographs accompany the description of the equipment; and the results of tests have shown that the construction of an apparatus of this type using standard film-transport mechanism has been fully justified.

No. 2 in the series is a paper on "Absolute Measurements in Magnetic Recording" by E. D. Daniel and P. E. Axon, and describes work carried out in the B.B.C. Research Department to establish methods of measuring the absolute sensitivity of the component parts of the recording–reproducing system. Another contribution from the Research Department is the third monograph, that on "The Visibility of Noise in Television", by R. D. A. Maurice, M. Gilbert, G. F. Newell and J. G. Spencer. This describes a comprehensive investigation of the effect of random noise on a television picture, its dependence on the non-linearity in the relevant portions of the transmission channels and the visibility of the noise as a function of frequency. The third part of this monograph comprises four photographs illustrating the effect of noise on a television picture for four values of the signal-to-noise ratio.

The fourth monograph is entitled "The Design of a Ribbon Type Pressure-Gradient Microphone for Broadcast Transmission", by D. E. L. Shorter and H. D. Harwood. This describes work leading to the development of an improved studio microphone for both sound and vision broadcasting, with a greatly reduced weight and volume and an extension in the range of uniform frequency-response.

Summaries of recent patent applications by the B.B.C. are also included in two of the monographs, each of which is issued in a distinctive two-tone blue cover. It is likely that the series will be of interest and value to engineers engaged in broadcasting and telecommunications generally both in Great Britain and overseas.

THE METEOROLOGICAL OFFICE

ANNUAL REPORT FOR 1954–55

THE annual report for 1954–55 of the Director of the Meteorological Office* records another year of steady progress and of honest endeavour by the Office to meet the ever-increasing demands for its services. There appears to be little need for special comment regarding two of its main functions: the provision of meteorological services for civil and military aviation, for shipping, for the general public by television, radio, telephone and through the Press, for special customers such as the railways, electricity and gas undertakings, farmers, river and road

* Annual Report of the Director of the Meteorological Office, presented by the Meteorological Committee to the Secretary of State for Air, for the Year April 1, 1954, to March 31, 1955. (M.O. 594.) Pp. 68. (London: H.M.S.O., 1955.) 2s. 6d. net.

engineers; and the collection, distribution and publication of meteorological data. These routine duties, which do not often reach the headlines (except when a forecast goes badly wrong on a Bank Holiday!), but which assume an ever-increasing importance in modern society, bear heavily on the Meteorological Office, which is under-staffed, poorly housed and under-financed. The total annual budget of the Office is less than £3 million—little more than the cost of a modern bomber. This is not a large sum on which to carry out its multifarious activities at home, to meet its overseas and international commitments, to develop new instruments and improved techniques and to undertake an extensive programme of research in meteorology and geophysics.

It is, of course, largely by the quality and scope of its research that the vitality and scientific reputation of such an organization must be judged. Considerable progress has been made during the past few years, and the present report shows that this has been maintained. There have been encouraging developments in the study of numerical forecasting with the aid of electronic computers, and it has recently been announced that the Office is to have a machine of its own. The Meteorological Research Flight has continued its investigations on the distribution of water vapour and ozone and the occurrence of clear-air turbulence at high altitudes, and into the structure and constitution of clouds. Progress was made in the measurement of solar radiation and in the development of the new radar-sonde. Some attention has also been given to the possibility of increasing rainfall by cloud-seeding, and preliminary field-trials have been started on Salisbury Plain.

The pace of all this work has necessarily been limited by the availability of personnel, and the Director stresses that the continued shortage of scientific staff and the high turnover-rate (about 20 per cent per year) of assistants are matters of some concern. The total number of scientific officers on the staff of the Office is only 155, not all of whom are actively or mainly engaged on research. More serious still, only four new officers were recruited during the year—barely enough to compensate for losses through retirement and resignation. How to attract sufficient numbers of high-quality physicists and mathematicians into a field which, after all, has great opportunities for research, is perhaps the main problem facing the Meteorological Office at the present time. One welcomes, therefore, the continued and extended co-operation between the Office and the universities, both of which have a responsibility for ensuring that Britain is not left behind in the great expansion now taking place in atmospheric physics.

B. J. Mason

PHYTOPLANKTON OF LAKE TANGANYIKA

For one who is not conversant with all the recent work in the biological study of lakes, there is much of interest in the volume by L. van Meel, entitled "Le Phytoplancton", one of a series of reports of the Belgian Expedition (1946–47) for the "Exploration Hydrobiologique du Lac Tanganika" (Institut Royal des Sciences Naturelles de Belgique. Bruxelles, 1954. 4, Fasc. 1. *A*, Texte (pp. 681); *B*, Atlas (pls. 76)). Likewise it will be particularly interesting to all those whose experience is limited to small temperate lakes. On the other hand, the title does not prepare the reader for the table of contents, which shows that geobotany, geochemistry and geophysics of all the central and eastern African lakes (and of nineteen in particular) fill pp. 7–250. The next two hundred and twenty-five pages are devoted to a list of the algae of these lakes, and the third section dealing with the ecology of the plankton occupies one hundred and seventeen pages, the phytoplankton of Lake Tanganyika being covered in thirty-four. This indicates that a more suitable title should have been chosen for a volume which is mainly a compilation of the available information of certain aspects of these African lakes, with the additional information collected by the Expedition about the phytoplankton of Lake Tanganyika. As a compilation, it will be a most useful book of reference to many, and the information gathered together here about any one lake will provide the basis for a fuller and more searching investigation of it. The contribution by British workers to our knowledge of these lakes is clearly brought out.

The size of Lake Tanganyika is one of its most striking characters. It is the second largest of the African lakes, with a volume approximately half that of the North Sea. It is also very deep (1,470 metres in the deepest trough), being exceeded only by Lake Baikal. These facts, together with its situation near the equator and the protection given by high land from the full force of the south winds, are some of the factors combining to preserve the stratification of the water and to reduce mixing to a minimum. It is stated to have greater thermal stability than any other lake, the variation in temperature at two hundred metres being less than 5/100 deg. throughout the year. The water is clear and well oxygenated down to a depth of 40–100 m., depending on the place and season, but from 100–225 m. to the bottom (the equivalent of three-quarters of the volume of the lake) there is no oxygen but an abundance of sulphuretted hydrogen. This is the result of the stratification (scarcely ever disturbed at these depths) and the reason for the statement that a total 'turn-over' would have disastrous consequences. It is supposed that even a partial 'turn-over' may not take place annually.

Tanganyika is a diatom lake, and in his investigations van Meel found no new species in the phytoplankton. The new information concerns rather the geographical distribution of the algæ, chiefly at the surface. The plankton of the bays is much richer than the pelagic plankton, which is poor in species (*Oocystis*, *Nitzschia*, *Anabaena*, *Anabaenopsis* being the common genera) rather than in individuals. During the Expedition's stay, the volume of plankton, however, was poor throughout most of the year, but an increase occurred in October 1946, at the end of the dry season. The permanent stratification of the deepest layers of water would appear to be an obvious reason for the poverty of the plankton, as the author suggests; but van Meel considers the inhibiting effect of light on chlorophyll to be an added reason. This would seem to control its position in depth in the Lake rather than its quantity. A certain amount of sampling at different depths leads to no obvious conclusions. With a small amount of plankton in such a large body of water, it is possible that its distribution is uneven due to currents and micro-stratifications. One set of readings appears to show a correlation with the diurnal movement of the zoo-

plankton; but as a result of the general consideration of the food-supply of the latter, van Meel puts forward a hypothesis that it may be provided by a bacterial flora rather than by the phytoplankton.

It is concluded that Lake Tanganyika should be classed as pseudo-eutrophic since it shows characters of both oligotrophic and eutrophic lakes. On the other hand, this unusual combination of characters might suggest the need for a revision of the classification of lakes.

This is a very lavish production, information being well displayed with the aid of a liberal supply of maps, tables and diagrams. A separate volume of seventy-six plates illustrates many species of the phytoplankton of these African lakes.

KATHLEEN M. DREW

THE PRODUCT OF THE HUMAN BLOOD GROUP *A* AND *B* GENES IN INDIVIDUALS BELONGING TO GROUP *AB*

By PROF. W. T. J. MORGAN, F.R.S., and DR. WINIFRED M. WATKINS
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INTEREST in the chemical nature and serological relationships of the substances which are responsible for the differentiation of human red blood cells into well-defined groups arises from two sources: these materials are of importance in the field of immunochemistry because each possesses a distinct serological specificity, and in the field of biochemical genetics because each characteristic specificity is believed to be the result of the action of a single gene.

The only human blood-group substances for which the chemical nature is known with any degree of certainty are those which characterize the *ABO* and *Lewis* systems, since these specific materials occur in the tissue fluids and secretions in a water-soluble form. The *A* and *B* substances have been isolated in an essentially homogeneous condition and a thorough study has been made of the chemical, physical and serological properties of these materials[1]. Comparatively little work has been carried out, however, on the material showing both *A* and *B* properties which is secreted by individuals belonging to group *AB*. The question arises whether the secretions in these heterozygous individuals contain molecules which carry both *A* and *B* specific groupings, or whether they contain a mixture of molecules some of which carry *A*, and others *B*, specificity. Wiener and Karowe[2], in their development of a diagrammatic representation of human blood-group reactions, assumed that in group *AB* individuals the molecules possess dual specificity; but chemical or serological evidence for the association of both specificities with one molecular species, or for the presence of molecules with single specificity only, has been lacking.

The close chemical and physical similarity of the *A* and *B* substances means that they are not separable by the usual fractionation procedures, including electrophoresis and ultracentrifugation, and therefore an attempt has been made to obtain evidence on this question by means of serological precipitation tests. The methods employed involved the precipitation of the specific group substance in (i) an artificial mixture of *A* and *B* substances, and (ii) the material obtained from *AB* individuals, with anti-*A* or anti-*B* precipitating sera; the specific activity of the original materials, the solutions remaining after removal of the precipitates and the redissolved precipitates was determined by means of agglutination inhibition tests. It was hoped thus to separate the specific materials contained in an artificial mixture of *A* and *B* substances and to determine the behaviour of the *A*- and *B*-specific activities present in the secretions of an *AB* person.

The blood-group materials used were preparations derived from human ovarian cyst fluids[3] which had been subjected to the phenol-extraction procedure[4], or fresh saliva samples which had received no treatment other than heating in a boiling water-bath, followed by centrifugation to remove insoluble material. Anti-*A* and anti-*B* sera prepared in the rabbit were used as precipitating reagents, and some additional experiments were carried out with a purified extract of Sieva Lima beans[5], which contains powerful anti-*A* precipitins. The precipitating reagents were freed from heterologous agglutinins or precipitins before use. The concentration of *A*, *B* or *AB* substance giving suitable precipitation with the appropriate reagent was determined and 1 ml. of a solution containing this concentration of material was then mixed with 1 ml. of the precipitating reagent. The mixtures were incubated 1 hr. at 37°, followed by standing over night at 0–4°, and the precipitates were then spun down at 0°, redispersed by high-speed stirring, washed three times with ice-cold saline, and dissolved in 0·2 ml. of *N*/10 sodium hydroxide. The solution was neutralized and the volume made up to 1 ml. with saline; finally, when rabbit precipitating sera were used, the solutions were heated 10 min. in a boiling water-bath to destroy the activity of any remaining antibody. This step was unnecessary when Sieva protein was used because its specific anti-*A* properties are rapidly destroyed by treatment with dilute alkali.

The results of an experiment using a rabbit anti-*A* serum as precipitant with a mixture of *A* and *B* cyst materials and with a substance obtained from a group *AB* cyst are shown in Table 1. The agglutination inhibition tests were carried out using a twofold dilution series of the test substance and a constant amount of antibody. The inhibition is expressed as the number of tubes which failed to show agglutination. When one considers the results obtained with the artificial mixture of *A* and *B* substances, it is evident that the supernatant solution remaining after removal of the specific precipitate has lost its capacity to neutralize the agglutinating action of anti-*A* serum on *A* cells, but retains, unimpaired, its capacity to inhibit the action of anti-*B* serum on *B* cells. The results given by the redissolved precipitate from the *A* and *B* mixture support these observations; the precipitate shows *A*-inhibiting activity but is without *B*-activity. These findings demonstrate, therefore, that it is possible to separate an artificial mixture of *A* and *B* substances by the precipitation technique.

Examination of the results obtained with the *AB* cyst material, on the other hand, reveals that after removal of the precipitate the supernatant solution shows an almost complete loss of *B* activity in addition to loss of *A* activity, and the precipitate

Table 1. Precipitation of an Artificial Mixture of *A* and *B* Cyst Substances and an *AB* Cyst Substance using Rabbit Anti-*A* Serum

Agglutination inhibition given by (*a*) the untreated solutions, (*b*) the supernatant fluids remaining after removal of the precipitates, and (*c*) the redissolved precipitates

Agglutination system used for final test	Preparation tested for inhibition		No. of tubes showing agglutination-inhibition
Human anti-*A* serum + A_1 cells	(*a*)	Untreated	
		A + *B* mixture	7
		„ *AB* substance	6
	(*b*)	Supernatant from	
		A + *B* mixture	0
		„ *AB* substance	0
	(*c*)	Precipitate from	
		A + *B* mixture	7
		„ *AB* substance	6
Rabbit anti-*B* serum + *B* cells	(*a*)	Untreated	
		A + *B* mixture	5
		„ *AB* substance	5
	(*b*)	Supernatant from	
		A + *B* mixture	5
		„ *AB* substance	1
	(*c*)	Precipitate from	
		A + *B* mixture	0
		„ *AB* substance	5

possesses both *A* and *B* activities in the same ratio as in the original solution. These results are typical of those obtained with three purified *AB* cyst materials which had originated from different individuals, one native cyst substance, five different A_1B saliva samples and two A_2B saliva samples. Substitution of the Sieva Lima bean precipitant for the rabbit antibody gave essentially similar results. When rabbit anti-*B* serum was used as the precipitating reagent, the reverse picture was obtained with the *A* and *B* mixture ; that is, *B* substance only was precipitated and removed from the mixture, whereas both the *A* and *B* activities were carried down in the precipitate from the *AB* cyst substance.

The evidence obtained from these experiments strongly indicates, therefore, that in the tissue fluids and secretions of secretors belonging to group *AB*, a large proportion, if not all, of the macromolecules showing blood group specificity possess both *A* and *B* properties. The fact that it has been possible to separate artificial mixtures of native *A* and *B* salivas into their serologically specific components indicates that the failure to separate the group factors in the saliva of an *AB* person is not due to the simple formation of complex aggregates when both specific substances are present. As an additional control, fresh native *A* and *B* saliva samples were incubated together at 37° for 1 hr., then heated at 100°, and examined as described above ; complete separation of the specific activities was again accomplished. The implications of these findings are of importance from the point of view of any biochemical approach to the nature of the materials secreted by *AB* individuals, and also must be considered in the application of quantitative precipitation tests to these substances.

It appears, therefore, that in heterozygous *AB* individuals the *A* and *B* genes give rise to a molecular species which differs from that produced by either gene in the homozygous state, and this fact is of considerable interest in human biochemical genetics. The interaction of genes in the heterozygote has received much attention in relation to hybrid vigour in plants and animals. In man, however, only two examples of the interaction of genes at a single locus have hitherto been worked out in biochemical terms. Haldane[6] quotes the findings of Filliti-Wurmser, Aubel-Lesure and Wurmser[7], on the molecular size of β-agglutinins, as an example where the heterozygote produces a product which differs from that produced by either of the genes in the homozygous condition. These authors found that the molecular weights of the β-agglutinins in *OO*, A_1A_1 and A_1O individuals were 170,000, 300,000 and 500,000, respectively. However, there is some difference of opinion as to whether the formation of the naturally occurring isoagglutinins is under direct genetical control[8]. The second example relates to the hæmoglobins produced in individuals carrying the sickle-cell trait. Neel[9] and Beet[10] put forward the hypothesis that the sickle-cell trait and sickle-cell anæmia occur respectively in individuals heterozygous and homozygous for the same abnormal gene. This gene was afterwards shown to be responsible for the production in the homozygote of a hæmoglobin which differs in its electrophoretic mobility and solubility from that present in normal individuals, and the sickle-cell gene is believed to be an allele of that which produces normal hæmoglobin[11]. In the cells of individuals heterozygous for this condition, that is, those carrying the sickle-cell trait, both the abnormal and normal types of hæmoglobin are found to be present and to migrate independently on electrophoresis.

It is evident, therefore, that no general rule as to the influence in man of genes heterozygous at a single locus can be drawn from the examples known at present. When one considers the results of Filliti-Wurmser *et al.*[7] on the molecular weight of β-agglutinins, and the behaviour of the *AB* blood-group substance reported here, the product in the heterozygote would appear to differ in molecular nature, although not in general specificity, from the product produced by either of the genes when present in the homozygous condition ; in the example of the hæmoglobin genes, on the other hand, the allele giving rise to the sickle-cell type of hæmoglobin and that producing normal hæmoglobin each gives rise to its own characteristic product in the heterozygote.

The method of approach outlined here involving the use of serological precipitation tests to determine whether more than one specificity is associated with a single molecular species is now being applied to preparations of *A*, *B* and *Lewis* substances showing *H* specificity[12]. It is hoped thus to obtain information which will help in the elucidation of the genetical relationships of the *H* character to the products of the *A*, *B* and *Lewis* genes.

We wish to thank Prof. W. C. Boyd for a gift of purified Sieva bean protein, and Drs. Glynn and Holborow for some of the anti-*A* and anti-*B* rabbit sera used in this investigation. These studies were aided by a grant from the Nuffield Trust. [Jan. 19

[1] Aminoff, D., Morgan, W. T. J., and Watkins, W. M., *Biochem. J.*, **46**, 426 (1950). Gibbons, R. A., and Morgan, W. T. J., *Biochem. J.*, **57**, 283 (1954). Gibbons, R. A., Morgan, W. T. J., and Gibbons, M., *Biochem. J.*, **60**, 428 (1955). Kabat, E. A., Bendich, A., Bezer, A. E., and Beiser, S. M., *J. Exp. Med.*, **85**, 685 (1947). Leskowitz, S., and Kabat, E. A., *J. Immunol.*, **75**, 171 (1955).
[2] Wiener, A. S., and Karowe, H. E., *J. Immunol.*, **49**, 51 (1944).
[3] Morgan, W. T. J., and Heyningen, R. van, *Brit. J. Exp. Path.*, **25**, 5 (1944).
[4] Morgan, W. T. J., and King, H. K., *Biochem. J.*, **37**, 640 (1943).
[5] Boyd, W. C., Shapleigh, E., and McMaster, M., *Arch. Biochem. Biophys.*, **55**, 226 (1955).
[6] Haldane, J. B. S., *Proc. Roy. Soc.*, B, **144**, 217 (1955).
[7] Filliti-Wurmser, S., Aubel-Lesure, G., and Wurmser, R., *J. Chim. Phys.*, **50**, 236 (1953).
[8] Weiner, A. S., *J. Immunol.*, **66**, 287 (1951). Race, R. R., and Sanger, R., "Blood Groups in Man" (Blackwell, Oxford, 1954).
[9] Neel, J. V., *Science*, **110**, 64 (1949).
[10] Beet, E. A., *Ann. Eugen. Lond.*, **14**, 279 (1949).
[11] Pauling, L., Itano, H. A., Singer, S. J., and Wells, I. C., *Science*, **110**, 543 (1949).
[12] Watkins, W. M., and Morgan, W. T. J., *Vox Sanguinis*, **5**, 1 (1955).

LETTERS TO THE EDITORS

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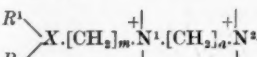
New Series of Ganglion-blocking Agents

POWERFUL ganglion-blocking properties have been found in the diquaternary-amino-carbinols (I), -alkenes (II), -alkanes (III), -nitriles (IV), -ethers (V) and -esters (VI) :



$$R^1 \diagdown \atop R_2 \diagup X.[CH_2]_m.\overset{+}{N}{}^1.[CH_2]_n.\overset{+}{N}{}^2 \text{—} \quad 2A^-$$

I ; $X = C(OH)CH_2$ IV ; $X = C(CN)CH_2$
II ; $X = C : CH$ V ; $X = CH.O$
III ; $X = CH.CH_2$ VI ; $X = CH.CO.O$

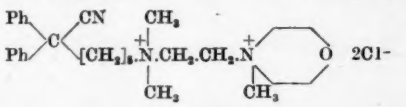
R^1 and R^2 are phenyl or *cyclo*hexyl groups in the compounds described in this communication, but preliminary results show that ganglion-blocking action also occurs when R^1 and R^2 are pyridyl or thienyl groups. $\overset{+}{N}{}^1$ and $\overset{+}{N}{}^2$ are fully substituted quaternary nitrogen atoms.

These compounds are structurally related to the large group of tertiary and quaternary amines of the benzhydrylalkyl type which has already yielded a number of clinically useful drugs. Thus, the new compounds I–III are related to the series of spasmolytics, antihistamines and analgesics which we have previously studied, for example, tricyclamol, procyclidine, triprolidine and the thiambutenes ; while series IV, V and VI are related to the methadone series of analgesics, the antihistamine diphenhydramine, and the spasmolytic 'Trasentin' respectively. The introduction of the group consisting of two quaternary nitrogen atoms linked by a short polymethylene chain, in place of the tertiary or quaternary amino-group of the known compounds, has conferred ganglion-blocking activity on all these classes of drugs and divested them of their previous types of activity. The new compounds have a structural feature in common with the methonium type of hypotensive agent, namely, two quaternary amino-centres, which in our compounds should preferably be separated by two or three methylene groups.

The pharmacological actions of a large number of these compounds have been examined in several species. The most prominent actions include lowering of blood pressure, antagonism of the hypertensive effect of intravenous doses of the ganglion-stimulating compound, N^1 : N^1-dimethyl-N^2-phenylpiperazinium iodide (DMPP), inhibition of vagal bradycardia and augmentation of the hypertensive effects of intravenous adrenaline and *l*-noradrenaline in anæsthetized cats and dogs. It is of interest that somewhat larger doses than those producing these effects have generally been required to block the effect of short periods of preganglionic stimulation on the nictitating membrane, which preparation is the one most commonly employed in the laboratory for the assessment of experimental ganglion block. However, the compounds have so far invariably prevented contractions of the nictitating membrane caused by preganglionic stimulation, but not those due to postganglionic stimulation or intravenous adrenaline. Some are powerful inhibitors of gastric secretion in pyloric-ligated rats ; in contrast to atropine-like compounds, they have been effective at doses considerably lower than those dilating the pupil. Mydriasis occurs after parenteral but not after local administration of the compounds ; their activity in this respect has so far been relatively greater in some species, for example, mice and cats, than in others, such as rats, dogs and man. They inhibit powerfully the peristaltic reflex of isolated guinea pig ileum, but not the peripheral muscarinic effects of acetylcholine on the isolated ileum or on the blood pressure of the cat. These findings indicate that the main pharmacological effects of the compounds are due to block of autonomic ganglia. The main toxic action is closely associated with neuromuscular block, which with many of the compounds has not occurred until after at least a hundred times the dose causing some ganglion blockade.

A number of relationships between structure and activity have emerged, based mainly on mydriatic action in mice but supported by other findings. As m has been increased from 1 to 7, activity has reached a maximum at $m = 3$ or 4 and then has declined, while duration of action has progressively increased. Toxicity in mice has slightly increased with the value of m, and when n has been increased from 2 to 6 toxicity has often increased as much as threefold. Activities have been greatest when the substituents on $\overset{+}{N}{}^1$ and $\overset{+}{N}{}^2$ have been no larger than ethyl, this also applying when $\overset{+}{N}{}^2$ formed part of a pyrrolidinium, piperidinium or morpholinium ring.

Some of these compounds are considerably more active in many laboratory tests than hexamethonium and pentolinium, and their effects last very much longer. A few have been successfully used clinically in the treatment of hypertension. These are highly effective in lowering blood pressure and relieving certain hypertensive symptoms, when given subcutaneously in doses of up to 40 mgm. or intravenously in smaller dosage ; the effects are slow in onset and persist for several hours. Like other quaternary ammonium salts, they are poorly absorbed after oral administration, the minimal effective dose by this route being about ten times the subcutaneous.



$$Ph_2C(CN)[CH_2]_3.\overset{+}{N}(CH_3)_2.CH_2.CH_2.\overset{+}{N}(CH_3)_2 \quad O \quad 2Cl^-$$

356*C*54

In these clinical trials the compound **356*C*54** has so far been one of the most promising. Subcutaneous injection of an effective dose of this drug has usually lowered the blood pressure for 7–12 hr. Side-effects have been minimal, apart from some variable and often temporary disturbances of vision, due to cycloplegic and mydriatic actions, which could be partly counteracted by either pilocarpine or eserine eye drops. When given in therapeutic dosage, it has less frequently caused recurrent postural syncope than have hexamethonium and pentolinium.

Another outstanding feature is that these drugs have not caused paralytic ileus or severe constipation, and apparently have only a slight effect on propulsion in the small intestine. However, they have powerfully inhibited gastric acid secretion and motility. This and the animal pharmacology suggest that another possible use of these compounds might be in the treatment of peptic ulceration.

Full investigation into the chemistry, pharmacology, clinical activity and use of these and related compounds is being actively pursued, and the results of these researches will be published in detail elsewhere.

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Effect of Cortisone on the Blood

Nicol and Snell[1] showed that the phagocytic activity of the reticulo-endothelial system becomes depressed during the first two weeks of cortisone treatment and recovers to about the normal level during the third and fourth weeks if the cortisone injections are continued. The present communication shows that cortisone also produces changes in the blood.

Twelve male guinea pigs were given a daily intramuscular injection of 10 mgm. of cortisone acetate (Roussel) for a period of five weeks. Blood was removed by heart puncture on the day prior to the commencement of the cortisone injections and thereafter at the end of each week. The blood films were stained with Giemsa's stain.

Erythrocytes. During the first two weeks of cortisone treatment, the degree of polychromasia and anisocytosis seen in the normal blood picture[2] became increased, and at the end of the second week immature red cells were present in greater numbers. No significant change was noted in the red-cell count; but there was a drop in the hæmoglobin-level from 81 to 70 per cent when tested by the Sahli method.

Leucocytes. The changes in the leucocytes are shown in Table 1.

Table 1. Leucocyte Counts from 12 Guinea Pigs each of which received 10 mgm. of Cortisone Daily for 5 Weeks

No. per cu.mm.	Control	Experimental results No. of weeks of cortisone treatment				
		1	2	3	4	5
Total number of leucocytes	8,700	6,950	4,200	5,100	10,200	9,300
Lymphocytes	5,600	4,800	1,300	1,700	2,700	1,500
Pseudo-eosinophils	2,800	1,900	2,900	3,400	7,200	7,600
Monocytes	300	250	—	—	300	200

The control results in Table 1 show the average number of leucocytes in the twelve animals on the day before the commencement of the cortisone injections; the experimental results give the average number of leucocytes in the animals at the end of each week of cortisone treatment.

It can be seen that the total leucocyte count dropped below normal during the first three weeks of the cortisone injections, then rose above normal during the fourth and fifth weeks of treatment. These changes were accounted for by a sustained fall in the number of lymphocytes and a gradual rise, after the first week, in the number of pseudoeosinophils. Moreover, when the pseudoeosinophil count dropped at the end of the first week, a high proportion of the cells showed multiple nuclear lobes, whereas from the second to the fifth week, as the pseudoeosinophils increased in number, a greater proportion showed a single nuclear lobe indicating increased production of polymorphs.

Yoffey[3] has shown that the administration of compound *E* (cortisone) in doses of 5 mgm. per day for seven days appears to stimulate the formation of red cells in the normal male guinea pig, together with a possible increase in the myeloid cells of the bone marrow. Antopol[4], working on the mouse, reported that a single dose of 2·5 mgm. of cortisone subcutaneously produced depression of the circulating lymphocytes and also an initial granulocytopœnia followed by granulocytosis. He also found that the erythrocyte count showed no significant difference between control and treated animals.

The above results show that the depression of the reticulo-endothelial system which occurs during the early stages of cortisone treatment[1] is accompanied by a fall of the total leucocyte count in the blood. The recovery of the phagocytic activity of the reticulo-endothelial system during the third and fourth weeks of cortisone administration is, however, not associated with a return to normal of the differential leucocyte counts, since the lymphocytes remain reduced in number and the pseudoeosinophils become markedly increased.

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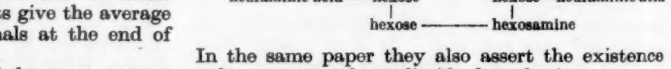
[1] Nicol, T., and Snell, R. S., *Nature*, **174**, 554 (1954); and communication in the press.
[2] Bilbey, D., and Nicol, T., *Nature*, [**176**, 1218 (1955)].
[3] Yoffey, J. M., *et al.*, *J. Anat.*, **88**, 115 (1954).
[4] Antopol, W., *et al.*, *Blood*, **6**, 513 (1951).

Composition of Gangliosides from Human Brain

Gangliosides are lipids closely allied to the cerebrosides. They were so named because of their occurrence mainly in the ganglion cells of the nervous system, although gangliosides seem to exist in most parenchymatous organs. Klenk *et al.*[1], for example, have isolated gangliosides from brain, spleen and red cells. The composition of ganglioside from brain as given by Klenk had to be modified after the isolation of chondrosamine from brain ganglioside by us[2], and in a recent paper Klenk *et al.* suggested its composition as follows:



In the same paper they also assert the existence of only one type of ganglioside from brain.

The value given for hexosamine by Klenk (7 per cent) is rather low when compared with the value earlier given by Blix[3] and later by Yamakawa and Suzuki[4].

Klenk *et al.* have also investigated the amount of ganglioside in human brain by determining the content of neuraminic acid. On testing the result with another extraction method, I found values 2–3 times higher than those reported by Klenk.

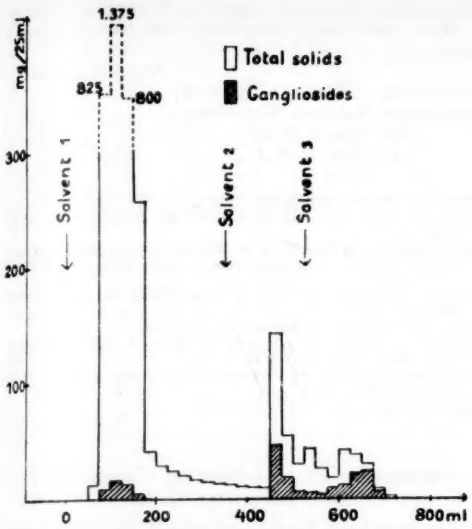


Fig. 1. Chromatogram of 4 gm. of brain lipids on a cellulose column 30 × 400 mm. Solvent 1, chloroform : ethanol : water = 16 : 4 : 1; solvent 2, chloroform : methanol : water = 5 : 15 : 1; solvent 3, methanol : water = 9 : 1

By the use of an improved method for the separation and the purification[5] of the gangliosides, these discrepancies have been found to be due to the existence of more than one type of ganglioside in human brain.

Grey matter from human brains was homogenized and dried with acetone. The dry substance was extracted with methanol : chloroform (2 : 1 v/v) in a Soxhlet apparatus and the extract evaporated *in vacuo* to dryness. The lipids were dissolved to make a 5 per cent solution in the solvent phase of a mixture of chloroform : ethanol : water (16 : 4 : 1) and placed on the top of a column of cellulose. The column was run with the same solvent until fractions with negligible amounts of solids appeared. The solvent was then changed to chloroform : methanol : water (5 : 15 : 1) and finally to methanol : water (9 : 1). As is seen in Fig. 1, two fractions of gangliosides were separated.

The ratio sialic acid : hexosamine was in the first fraction 3 : 1 and in the second one 12 : 1. (Sialic acid has been isolated from brain gangliosides[6] and is supposed to be the naturally occurring acid in gangliosides.) The gangliosides from the first fraction were contaminated with a large amount of low-molecular substances and formed strands just as the so-called strandin of Folch[7].

The chloroform : methanol eluates from several runs were taken together, dialysed against distilled water at 4° C. and rechromatographed. A main fraction of fairly pure ganglioside was obtained and crystallized from ethanol : water. The crystals, small birefringent rods, were found to be the potassium salt of ganglioside.

Analytical data (calculated on the free ganglioside acid): P, 0 per cent, total-N, 2·97 per cent, hexose (calculated as galactose), 24·6 per cent, chondrosamine (free), 11·6 per cent, sialic acid, 24·1 per cent.

With regard to these data it is likely that the summary formula is as follows:

Fatty acid—sphingosine—hexose—hexose—chondrosamine—sialic acid

I have not yet succeeded in crystallizing the second fraction.

In some pathological conditions, especially in Tay-Sach's disease, the nerve cells are distended by gangliosides. In the brain of an individual suffering from the infantile type of this disease I found mainly gangliosides of the type described above.

A detailed report of this work will be given elsewhere.

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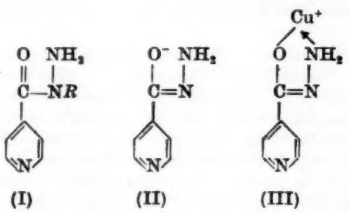
[1] Klenk, E., *Z. physiol. Chem.*, **273**, 76 (1942). Klenk, E., and Rennkamp, F., *ibid.*, **273**, 253 (1942). Klenk, E., and Lauenstein, K., *ibid.*, **295**, 164 (1953).
[2] Blix, G., Svennerholm, L., and Werner, I., *Acta Chem. Scand.*, **6**, 358 (1952).
[3] Blix, G., *Scand. Arch. Physiol.*, **80**, 46 (1938).
[4] Yamakawa, T., Suzuki, S., and Hattori, T., *J. Biochem.* (Tokyo), **40**, 611 (1953).
[5] Svennerholm, L., *Acta Chem. Scand.*, **8**, 1108 (1954).
[6] Svennerholm, L., *Acta Chem. Scand.*, **9**, 1033 (1955).
[7] Folch, J., Asrove, A., and Meath, J. A., *J. Biol. Chem.*, **191**, 819 (1951).

Mode of Action of Isoniazid

ISONIAZID (*iso*nicotinylhydrazide), which has proved remarkably successful in the treatment of human tuberculosis, has an affinity for the ions of heavy metals. This affinity is only slightly less than those of the common amino-acids[1]. It has been claimed that the action of isoniazid (I, R=H) against the tubercule bacillus *in vitro* is increased in the presence of copper[2]. Hence it was suggested that chelation (formation of cyclic metallic complexes) played a part in the therapeutic action of this drug.



In order to form metal complexes, for example, (III), isoniazid must first form the anion (II), which is the chelating species. No anion can be formed by 1-*iso*nicotinyl-1-methylhydrazine (I, $R = CH_3$). This substance has recently been synthesized and found to be virtually inactive[3], thus giving strong support to the hypothesis of chelation.

In the present communication, the determination of the avidity of other hydrazides for heavy metals is recorded. It is seen from Table 1 that of the two isomers of isoniazid, nicotinic hydrazide (which is biologically inert) has approximately the same affinity for metals as isoniazid, whereas picolinic hydrazide, which is about eight times less effective biologically, has 10^3–10^5 times the affinity for metals. Table 1 also includes an aromatic, and an aliphatic, hydrazide which have much the same avidity for metals as isoniazid but have far less biological activity. Thus, although the ability to form chelate compounds seems to be essential for the functioning of isoniazid, it now becomes clear that some other factor is of over-

Table 1. Physical and Anti-tubercular Properties of Hydrazides

	Isonicotinic	Nicotinic	Picolinic	Benzoic	Cyanacetic
Ionization constants (as pKa)					
NH_2	1·85 ± 0·04	1·86 ± 0·03	<1	3·03 ± 0·01	2·34 ± 0·02
Ring-N	3·54 ± 0·04	3·29 ± 0·04	2·86 ± 0·01	none	none
Acidic	10·77 ± 0·05	11·47 ± 0·04	12·27 ± 0·04	12·45 ± 0·03	11·17 ± 0·04
Stability constants					
Cu^{++} log K'	8·0	8·7	12·4	9·0	8·5
log K''	*	7·5	9·1	*	7·1
log K_s	—	16·2	21·5	—	15·6
Ni^{++} log K'	5·5	6·0	10·7	6·3	6·0
log K''	*c.* 4·3	4·7	9·5	*	*
log K_s	*c.* 9·8	10·7	20·2	—	—
Co^{++} log K'	4·8	5·4	9·6	*	5·3
log K''	*	*	7·8	—	*
log K_s	—	—	17·4	—	—
Zn^{++} log K'	5·4	*	8·4	*	*
log K''	*	—	7·2	—	—
log K_s	—	—	15·6	—	—
Fe^{++} log K'	*	*	8·4	*	*
log K''	—	—	*	—	—
log K_s	—	—	—	—	—
Biological action					
In vitro μgm. per ml. greatest dilution permitting survival (*a*)	0·025	25·0	1·5	12·5	3·0
In vivo mgm./kgm. smallest daily dose permitting survival (*b*)	3	no action	25	no action	**
In vivo mgm./kgm. smallest daily dose permitting survival (*c*)	2	**	**	**	10

* Precipitate.
** Not attempted.
– Calculation impossible because of precipitate.
(*a*) Prof. R. Knox, unpublished results on *H* 37 *Rv.* strain in Dubos medium (semi-solid). All substances were tested simultaneously.
(*b*) Berenstein, J., Loft, L., Steinberg, B., and Yale, H., *Amer. Rev. Tuberc.*, **65**, 357 (1952). Survival of mice, *H* 37 *Rv.* strain (drug given orally).
(*c*) Barnett, M., Bushby, S., Goulding, R., Knox, R., and Robson, M., *Brit. Med. J.*, ii, 647 (1955). Survival of mice, *CN* 3679 strain (human). Drug given subcutaneously, the isoniazid-treated mice survived longer than those treated with cyanacetic hydrazide.

riding importance. The incorporation, by the living cell, of isoniazid into diphosphopyridine nucleotide[4] (in the place of nicotinamide) does not explain its antitubercular action, because cyanacetic hydrazide is not a structural analogue of nicotinamide. Yet cyanacetic hydrazide, although weak, has been used successfully in human tuberculosis[5], and is apparently acting in the same way as isoniazid, because organisms resistant to one are resistant to the other[6].

The specificity of these hydrazides for *M. tuberculosis* has yet to be explained: none of the substances in Table 1 was bacteriostatic to *Staph. aureus* or *Strept. haemolyticus* in broth at *p*H 7·3 (37° for 24 hr.) even at 10^{-3} *M*, whereas 8-hydroxyquinoline (control) inhibited both organisms at 10^{-5} *M* (Marshall, J. H., unpublished work).

The ionization constants were determined by potentiometric titration at 20°, the two basic functions being separated by the method of Noyes[7]. The stability constants (K' for the 1 : 1 complex, for example, III, K'' for the complex formed by adding one more ion of ligand, and K_s, which is the product of K' and K'') were obtained by potentiometric titration in the presence of one equivalent of the metal ion[8].

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[1] Albert, A., *Experientia*, **9**, 370 (1953).
[2] Sorkin, E., Roth, W., and Erlenmeyer, H., *Helv. Chim. Acta*, **35**, 1736 (1952).
[3] Cymerman-Craig, J., Rubbo, S. D., Willis, D., and Edgar, J., *Nature*, **176**, 35 (1955). Cymerman-Craig, J., and Willis, D., *J. Chem. Soc.*, 4315 (1955).
[4] Zatman, L., Kaplan, N., Colowick, S., and Ciotti, M., *J. Biol. Chem.*, **209**, 467 (1954).
[5] Scheu, H., *Schweiz. Z. Tuberk.*, **11**, 77 (1954).
[6] Barnett, M., Bushby, S., Goulding, R., Knox, R., and Robson, M., *Brit. Med. J.*, ii, 647 (1955).
[7] Described in Britton, H., "Hydrogen Ions", 198 (London: Chapman and Hall, 1942).
[8] Albert, A., *Biochem. J.*, **47**, 531 (1950).

Formation of Iron-binding Compounds by Micro-organisms

The metabolic activity of certain micro-organisms is well known to be dependent on the iron concentration of the culture medium. For example, where cultured at controlled levels of iron, *Corynebacterium diphtheriae*[1] and *Aspergillus niger*[2] produce large amounts of toxin and citric acid respectively. Recently we have reported[3] the production of ferrichrome A by *Ustilago sphaerogena* when this fungus is grown under conditions of controlled iron supply.

In the present investigation a study has been made of the tendency of various microbial species to form iron-binding compounds under conditions similar to those used[3] for the production of ferrichrome A. The results demonstrate that at least three species (*Bacillus subtilis*, *Aspergillus niger* and *Bacillus megaterium*) can be induced to form such compounds. Several strains of *Bacillus subtilis* and *Bacillus megaterium* were examined and found to give essentially similar results.

The analytical measure employed to follow the formation of the iron-binding substances consisted in the addition to 4 ml. of the cell-free medium of 1 ml. of a solution containing 1 mgm. per ml. of ferric ion or, alternatively, ferrous ion followed by aeration. The optical density of such solutions was then measured at the wave-length of maximum absorption of the principal coloured iron complex present. These wave-lengths, as established on the extracted and purified substances, were 510, 440 and 440 mμ for the *Bacillus subtilis*, *Aspergillus niger* and *Bacillus megaterium* cultures, respectively.

In a series of experiments designed to show that only intermediate levels of iron are effective, the basal medium[3] was treated with 8-hydroxyquinoline and extracted with chloroform prior to sterilization and inoculation. The formation of the ferric-ion binding agent by *Bacillus subtilis* as a function of time and initial iron concentration is shown in Fig. 1. The product of this fermentation, the ferric derivative of which exhibits a deep purple colour at neutral *p*H, has been purified by solvent-extraction procedures and appears to have the general properties of a polyhydric phenol. The chemical nature of the compounds formed by *Aspergillus niger* and *Bacillus megaterium* (Table 1) is unknown, although judging from their spectra they may be more closely related

Table 1. FORMATION OF FERRIC ION-BINDING COMPOUNDS BY *Aspergillus niger* AND *Bacillus megaterium*

	Optical density (cm.$^{-1}$ at 440 mμ)					
	A. niger			*B. megaterium*		
Iron (μgm./l.)*	nil	20	100	nil	20	100
Time (hr.)						
22	0·14	0·12	0·15	0·20	0·34	0·13
32·5	0·09	0·07	0·09	0·42	0·62	0·24
46	0·20	0·34	0·08	0·41	1·20	0·29
57	0·52	0·56	0·27	0·27	0·90	0·21
79·5	1·50	0·95	0·39	0·17	0·60	0·14

* No detectable iron-binding compounds were observed with initial iron concentration of 500 μgm./l. or greater.

to ferrichrome[4] or ferrichrome A [3]. The ferric chelate of citric acid, although yellow in colour, does not have an absorption maximum in the higher wavelength region employed in the present work.

Escherichia coli and a *Pseudomonas* species, when grown in the unpurified medium, gave no visual evidence of the formation of iron-binding agents. It is, of course, conceivable that some of these compounds might provide colourless derivatives with ferric ion; in that event they would be more difficult to detect. Our success in finding the substances with the three species described above may be connected with the more vigorous growth and higher iron requirement of the bacilli and fungi.

From our results (Fig. 1 and Table 1) it is clear that the extracellular appearance of the iron-binding substances is strongly dependent on the initial iron-level of the medium. This suggests that these compounds are involved in an iron sequestering and transferring system, the latter either initiated or magnified by the organism during iron deficiency. The substances mentioned here form very stable ferric derivatives, probably chelate compounds, since the bound iron cannot be precipitated even at *p*H values of 10–11. We have repeatedly observed that, when the test organisms are grown in stainless steel fermentation equipment, no trace of iron-binding substances can be found.

An alternative explanation for the mode of action of the new compounds would be that they act as a by-pass around the normal terminal electron transport chain. It is of interest that all of these ferric chelates can be reduced with hydrosulphite and are very rapidly autoxidizable.

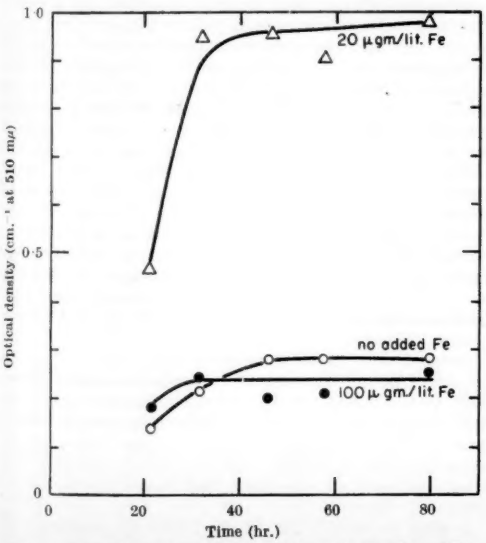

Fig. 1. Formation of iron-binding substance by *Bacillus subtilis* as a function of time and initial iron concentration

Bacillus subtilis, but not *Bacillus megaterium* or *Aspergillus niger*, excretes large amounts of porphyrin in addition to the ferric ion-binding agent described above. This porphyrin has been shown by P. M. Townsley in this laboratory to be mainly coproporphyrin III.

Further experiments are in progress with the iron-binding substances produced by micro-organisms. Of particular interest is the study of their structure, specificity for metal ion (stability) and biological activity.

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[1] Pappenheimer, A. M., "Adv. Prot. Chem.", **4**, 123 (1948).
[2] Shu, P., and Johnson, M. J., *Indust. Eng. Chem.*, **40**, 1202 (1948).
[3] Garibaldi, J. A., and Neilands, J. B., *J. Amer. Chem. Soc.*, **77**, 2429 (1955).
[4] Neilands, J. B., *J. Amer. Chem. Soc.*, **74**, 4846 (1952).

Amino-Acid Sequence in a Hypertensin

THE isolation and purification of a hypertensin peptide, resulting from the action of rabbit renin on ox serum, have been described recently by one of us. Its amino-acid composition was consistent with a decapeptide structure containing the following eight amino-acids: leucine (1), phenylalanine (1), tyrosine (1), proline (1), aspartic acid (1), arginine (1), valine (2) and histidine (2). Application of the fluorodinitrobenzene technique of Sanger showed that the N-terminal residue was aspartic acid[1]. The amino-acid sequence in this peptide has been determined by the following methods:

(1) Treatment with carboxypeptidase in the presence of di*iso*propyl phosphorofluoridate revealed leucine as the C-terminal amino-acid. The two adjacent amino-acids were shown to be phenylalanine and histidine; but their sequence could not be determined by the technique used.

(2) Partial acid hydrolysis with concentrated hydrochloric acid (36 per cent w/w) at 37° for three days, followed by paper chromatography to separate the products, yielded histidyl leucine. The remaining peptides could not be purified. It follows that the C-terminal sequence is · · · ·Phe·His·Leu.

(3) Stepwise degradation by the Edman method[2] indicated the N-terminal sequence Asp·Arg·Val·Tyr· · · ·.

(4) Trypsin digestion split off the peptide Asp·Arg which was isolated by paper chromatography. Application of the fluorodinitrobenzene technique to the whole digest showed that valine was the N-terminal residue of the other peptide. This confirmed the N-terminal sequence Asp·Arg·Val · · · · in hypertensin.

(5) Chymotrypsin digestion gave three products which were separated by paper electrophoresis; two tetrapeptides, (*a*) and (*b*), containing Asp, Arg, Val, Tyr, and His, Pro, Val, Phe, respectively, and the dipeptide His·Leu. Treatment of the digest with fluorodinitrobenzene revealed Asp, Val and His as the N-terminal residues of these peptides. Valine was therefore the N-terminal residue of peptide (*b*).

The C-terminal sequence · · · ·Val·Tyr was confirmed in peptide (*a*) by means of carboxypeptidase. Peptide (*b*) gave only phenylalanine even after digestion for 18 hr. at 37° with the enzyme at an enzyme : substrate molar ratio of approximately 1 : 40. This indicated the sequence · · · ·Pro·Phe, and this was supported by the results of the Edman degradation on peptide (*b*), which showed that the sequence of the first three residues was Val·His·Pro· · · ·.

(6) The action of aminopeptidase[3] : although not useful in our hands for elucidation of the sequence in hypertensin on account of the very rapid liberation of all the amino-acids present, aminopeptidase liberated free aspartic acid and not asparagine. In view of the optical specificity of this enzyme, the amino-acids in hypertensin must have the L-configuration.

The sequence of residues in this hypertensin is therefore Asp·Arg·Val·Tyr·Val·His·Pro·Phe·His·Leu. Confirmation of this structure is being attempted by synthesis.

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[1] Peart, W. S., *Biochem. J.*, **60**, vi (1955); *Nature*, **177**, 132 (1956); *Biochem. J.*, **62**, 520 (1956).
[2] Edman, P., *Acta Chem. Scand.*, **4**, 283 (1950). Fraenkel-Conrat, H., Harris, J. I., and Levy, A. L., in "Methods of Biochemical Analysis", **2**, edit., Glick (Interscience Pub., N.Y., 1955).
[3] Smith, E. L., and Spackman, D. H., *J. Biol. Chem.*, **212**, 271 (1955).

The Pigment, Trichosiderin, from Human Red Hair

Sorby[1] first described the pink pigment extractable from human red hair by hot acids, and its properties were further investigated by Flesch and Rothman[2]. In strongly acid solutions, the absorption curve shows a hump above 475 mμ with a maximum at 535 mμ (Fig. 1, curve 4), but this disappears at alkaline *p*H. Complete extraction of trichosiderin does not appreciably change the hair colour, and the contribution of this substance to the total pigmentation is uncertain.

In the present work bright red hair from a single subject, chosen because of its very high yield of trichosiderin, was studied. The washed hair was suspended in *N*/10 sodium hydroxide (100 mgm./10 ml.) at room temperature for 12 hr.; the hair swelled but did not disintegrate. The resulting orange-yellow extract (curve 1) was carefully neutralized and a further amount of concentrated hydrochloric acid (specific gravity, 1·18) was added to give a final concentration of 6 per cent. A white precipitate was centrifuged off, leaving a pale yellow supernatant (curve 2). Since the *p*H of the acidified extracts was in the region of 0·2, it is clear from the absorption curve that trichosiderin could not have been present. On heating the extract in a water-bath at 100° C., however, a pink colour developed within five minutes, and the solution also showed a reversible change to yellow at alkaline *p*H and pink pigment could be precipitated out at *p*H 7·0 as described by Flesch and Rothman[2]. It seems, therefore, that weak alkali extracts a precursor which is readily converted to trichosiderin on heating in acid. Approximately the same amount of trichosiderin is obtained either by direct acid extraction or by alkali extraction followed by acidification and heating (curves 3 and 4).

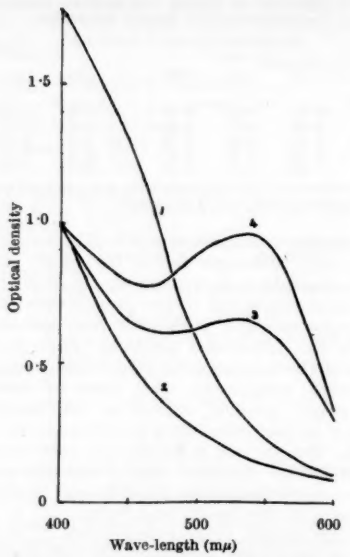

Fig. 1. Absorption curves of hair pigment extracts from strong red hair of a single subject. Cell length, 1·0 cm.; 100 mgm. hair/5·0 ml. solvent. (1) Extract in *N*/10 sodium hydroxide for 12 hr. at room temperature. (2) Curve 1 acidified to 6 per cent with conc. hydrochloric acid. (3) Curve 2, after holding at 100° C. for 30 min. (4) Direct acid extract with 6 per cent hydrochloric acid for 2 hr. in a sealed tube

The use of *N*/1 sodium hydroxide results in partial destruction of the trichosiderin precursor and also extracts other red pigments which are insoluble in acid and may be the main pigmentary components.

If acidified but unheated alkali extracts (*N*/10 sodium hydroxide) are chromatographed on a talc-'Celite' column[3], the orange-yellow pigment remains at the top and the colourless eluate yields no trace of trichosiderin on acidification and heating. If the pigment is then run off the column by addition of dilute ammonia, the yield of trichosiderin from the fractions is clearly related to the intensity of their initial yellow colour. The pigment from alkali extracts can also be adsorbed at the top of a magnesium carbonate column[4], forming a strongly red-brown layer which is not shifted by a variety of solvents, including aqueous solutions of ethylene chlorhydrin or of urea. If the pigment is removed by extrusion, a strong pink colour develops on heating it in acid solution. It is likely, therefore, that the trichosiderin precursor is an acid-soluble yellow or orange pigment.

Some twenty specimens covering a wide range of non-red hair colours and including albino hair yielded pale yellow alkali extracts which became paler on acidification but did not yield trichosiderin when heated. The absorption curves of these yellow alkali extracts have a simple concave form, whereas the alkali extract of strongly red hair (curve 1) is distinctly sigmoid.

I wish to thank Dr. S. P. Datta for making *p*H measurements with the glass-electrode, and the

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[1] Sorby, H. C., *J. Anthrop. Inst.*, **8**, 1 (1878).
[2] Flesch, Peter, and Rothman, Stephen, *J. Invest. Dermat.*, **6**, 257 (1945).
[3] Smyth, J. R., Porter, J. W., and Bohren, B. B., *Physiol. Zool.*, **24**, 205 (1951).
[4] Serra, J. A., *Nature*, **157**, 771 (1946).

Determination of Arginine

The orange-red colour produced by arginine and other mono-alkyl guanidines in the presence of α-naphthol and hypochlorites or hypobromites[1] would probably be more widely used in analysis, were existing methods capable of a stable calibration or more reproducible.

In 1948, Sakaguchi[2] introduced oxine in place of α-naphthol with some improvement; but his adaptation used the rather inferior analytical procedure of Weber[3]. The substitution of oxine for α-naphthol in Macpherson's method[4] brings about a most striking all-round improvement. Sensitivity is increased, the blank colour in the absence of arginine is reduced, a linear and stable calibration can be obtained and the standard error of a single measurement is reduced to rather less than 1 per cent compared with 4 per cent for the original Macpherson procedure. The intensity of colour varies with temperature; therefore, the reagents prior to mixing, and the solution up to the time of measurement, should be kept in a thermostat. The calibration of a Spekker absorptiometer (using Kodak Non-Photographic Filter No. 549) has not varied over two years.

7-Chloro-oxine gives yet higher sensitivity and lower blanks than oxine. The concentration of the hypobromite solution should, however, be only 60 per cent of that used for oxine and α-naphthol. When arginine is determined in whole protein hydrolysates, some density is always contributed by other amino-acids[5]. The absorption spectrum due to the other amino-acids differs from that of the Sakaguchi colour, but overlaps it and cannot be eliminated by choice of filter. The density due to other amino-acids produced with 7-chloro-oxine amounts to only about half that obtained with oxine or α-naphthol. 5 : 7-Dichloro- and 5 : 7-dibromo-oxine show still lower blank densities; but the lower solubility of these two compounds makes it difficult to employ a sufficient concentration to get the highest sensitivity. They replace oxine with advantage in the detection of alkyl-guanidines on paper chromatograms by methods analogous to that of Jepson and Smith[6].

A number of other derivatives of oxine α-naphthol and related compounds are being examined.

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[1] Sakaguchi, S., *J. Biochem.* (Tokyo), **5**, 133 (1925).
[2] Sakaguchi, S., *Jap. Med.*, **1**, 278 (1948) (almost identical with *J. Biochem.*, Tokyo, **37**, 219 (1950)).
[3] Weber, C. J., *J. Biol. Chem.*, **86**, 217 (1930).
[4] Macpherson, H. T., *Biochem. J.*, **40**, 470 (1946).
[5] Mellon, E. F., Korn, A. H., Kokes, E. L., and Hoover, S. R., *J. Amer. Chem. Soc.*, **73**, 1870 (1951).
[6] Jepson, J. B., and Smith, I., *Nature*, **172**, 1100 (1953).

Electrical Activity in the Cockroach Cerebrum

Information concerning electrical activity within the central nervous system of the higher invertebrate phyla is unusually meagre. This has been partially due to the inadequacy of recording techniques. It has proved possible, however, using capillary microelectrodes of less than 0·5μ tip diameter, to make recordings from the cockroach (*Periplaneta americana*) proto- and deutero-cerebrum, and to correlate particular types of activity with specific structures within the brain. In the central nervous system of insects, as in most other invertebrates but unlike the vertebrates, the neuron somata are separated from the synaptic (neuropile) regions.

The cockroach was fixed with pins and 'Plasticene' so that the thoracic and abdominal spiracles remained open for respiration while the head was bathed with a perfusion fluid[1] made isotonic with 0·1 *M* sucrose. The brain was exposed by removing the ocelli and frontal surface of the head capsule. After desheathing the protocerebrum and antennal lobes, microelectrodes filled with 3 *M* potassium chloride could be inserted at will. Electrode positions were roughly determined by measurement from the surface contours and later verified in the fixed and sectioned brain. Electrical stimulation was applied to the antennal nerve 1–2 cm. from the head.

Characteristic responses to stimulation were found in the antennal glomeruli, where sensory fibres join up with association neurons, and in most structures of the homolateral protocerebrum. The most prominent response, however, came from the homolateral corpora pedunculata. This was a large, extracellularly recorded, negative spike (often more than 30 mV. in the calices and peduncle) which apparently resulted from synchronized activity in the processes of the globular cells of the corpora pedunculata. It rapidly became fatigued at stimulation frequencies of more than 1 per sec., and had a rather variable latency (40–70 m.sec.). Occasionally the spike was repeated once or twice at approximately 10-m.sec. intervals; but in most preparations it was single. The form of the spike in the different regions of the corpora pedunculata suggests that it originated in the calices and passed down the peduncle to the α- and β-lobes, where it terminated (Fig. 1). This was substantiated by latency differences between the calyx and the α- and β-lobes. Pre-spike activity was most prominent in the calices, and was presumed to result from activity in association fibres coming from the antennal glomeruli. In addition to the large synchronized spike, repetitive discharges in single units and slow potential changes were recorded from various regions of the corpora pedunculata. In some of the cases, slow potentials seemed to be associated with an inhibition of small amplitude, spontaneous activity.

Cockroaches usually jump suddenly when an antenna is pinched or otherwise strongly stimulated. It was first thought that the large corpora pedunculata spike described above might be associated with this generalized response. Recordings from the thoracic nerve cord eliminated such a possibility, however, for the latency of the giant fibre responses in the thorax which mediated the jump response was less than 10 m.sec. These thoracic responses also remained when the major portion of the homolateral corpora pedunculata was removed, indicating a direct connexion between the antennal nerve and giant fibres

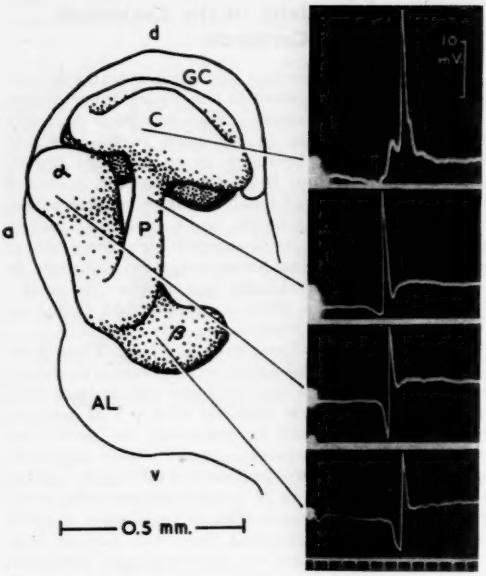

Fig. 1. Diagram of cockroach brain (lateral view) showing responses to antennal stimulation obtained in varying portions of corpora pedunculata; *C*, calyx; *P*, peduncle; *α*, α-lobe; *β*, β-lobe; *GC* globular cell bodies the processes of which form most of the corpora pedunculata; *AL*, antennal lobe; *d*, dorsal; *a*, anterior; *v* ventral. Upwards on records is negative; 10-m.sec. time marker; stimulus artefact triggered sweep

leaving the lower portion of the deutero-cerebrum. Although further ablation studies suggested that the corpora pedunculata are important in antennal function and locomotion, the role of the large spike remains unknown. If tracts connect the α-lobe of the corpora pedunculata with the antennal lobe, as recently described in the Hymenoptera[2], the large spike could be a link in a circular pathway: antennal glomeruli – corpora pedunculata (calyx to α-lobe) – antennal lobe.

More complete analyses of the corpora pedunculata responses and other activity in the cockroach brain are in progress and will be reported elsewhere.

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[1] Hoyle G., *J. Exp. Biol.*, **30**, 121 (1953).
[2] Vowles D. M., *Quart. J. Micro. Sci.*, **96**, 239 (1955).

A New Quantitative Method for Antigen–Antibody Titrations in Gels

Various methods have been devised for the quantitative analysis of precipitating antigen–antibody systems in gels[1–4]. Because they each involve intricate and time-consuming measurements there still exists the need for a simple assay technique in which conditions are readily stabilized and duplicated, and in which the end-point does not depend on the precise measurement of precipitation band distances. Such a method is now reported.

It is a modification of the Ouchterlony[5] punch-plate double diffusion technique. A stainless steel punch was designed to cut simultaneously a large central well and six smaller equidistant peripheral wells in poured agar plates. The body of the punch and central cutter were machined from a solid billet of stainless steel, the cutter being bored to $\frac{18}{32}$ in. inner diameter and turned to $\frac{1}{2}$ in. outer diameter. The peripheral cutters were made from $\frac{1}{4}$ in. bore stainless steel hypodermic tubing and set into holes drilled in the punch body. All cutters were chamfered on the inside to provide a razor-fine cutting edge. Distances between opposing edges of central and peripheral cutters, as measured with a travelling microscope, are $5{\cdot}78 \pm 0{\cdot}06$ mm., an accuracy of ± 1 per cent.

In practice, 1 per cent clarified New Zealand agar in saline, with 1 per cent sodium azide as preservative, is poured into $2\frac{1}{2}$ in. Petri dishes, 8 ml. per dish. After the gel has set in the refrigerator, the punch is placed centrally on the gel and pressed down with a firm, quick thrust. A capillary tube attached to a water vacuum pump is inserted down the shaft of each cutter in turn and the agar plug removed by suction. On withdrawal of the punch a pattern of clean-walled, uniformly placed wells is left in the agar. Dozens of identical plates can be prepared quickly in this way.

Into the large centre well 3–4 drops of antiserum are deposited and a glass or aluminium plug, about three-fourths the diameter of the well, placed centrally. The latter serves merely as a space-filler to spare antiserum. The Petri dish is closed and stored at 37° C. over saline in a canister, to prevent drying. 48–72 hr. later, depending on predetermined conditions for each antigen–antibody system, accumulated saline is removed from the peripheral wells and suitable dilutions of antigen added in clockwise direction, the starting well being noted by a pencil mark on the Petri dish. Each well is filled flush with its rim. After further incubation for 24 hr. the precipitation lines have formed and remain constant indefinitely thereafter.

At those wells where antigen concentration is relatively high the precipitation bands develop as an arc or parabola. Around wells of lower antigen concentrations a circle of precipitate is formed, completely surrounding the well. The first well which is completely encircled is taken as the end-point.

This end-point is objective and unequivocal. It seems capable of distinguishing between differences in concentration of the order of 10 per cent. Plates set up in duplicate and triplicate have uniformly given identical end-points. Though the end-point seems constant from one time to another if conditions are carefully controlled, for routine assays it is probably preferable to include a reference antigen as a standard.

So far this study has been based mostly on a system of anti-golden rod pollen rabbit serum versus a commercial golden rod pollen extract. As the extract came as a 50 per cent glycerine–saline solution, 50 per cent glycerine–saline was used as the diluent. Dilutions used began at 1 : 10 and rose by steps of 2 through the next five wells to 1 : 20.

Other systems have also been briefly examined and the technique described seems to be generally applicable. It has been noted that where two major antigens are present in a system it is possible to titrate for each independently, each antigen present-

ing a well-circling precipitation band at its own distinctive dilution. When conditions are suitably chosen the two end-points may appear on a single plate.

I am indebted to Mr. C. G. Green and Mr. R. D. Peters of the Instrument Section for construction of the punch.

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[1] Becker, E. L., Munoz, J. Lapresle, C., and Le Beau, L. J., *J. Immunol.*, **67**, 501 (1951).
[2] Oudin, J., "Methods in Medical Research" Year Book Publishers, Chicago, **5**, 335 (1952).
[3] Oakley, C. L., and Fulthorpe, A. J., *J. Path. Bact.*, **65**, 49 (1953).
[4] Augustin, R., and Hayward, B. J., *Int. Arch. Allergy and Appl. Immunol.*, **6**, 154 (1955).
[5] Ouchterlony, Ö., *Ark. Kemi. Min. Geol.* **26**, B 1 (1949).

Irradiation of Thiourea : Effect of Dose-rate upon the Chain Reaction

THIOUREA in aqueous solution is known to exert a highly protective power in radiation experiments[1]. When thiourea is irradiated with X-rays, gamma-rays or electrons, free sulphur is liberated[2].

A quantitative investigation of this reaction reveals interesting and unusual features. Apart from dependence upon *p*H and concentration and certain shifts of the *p*H in unbuffered solutions, oxygen has a greater effect than in other oxygen-dependent reactions. The yields, which are very low in absence of oxygen, are increased about four times in air-saturated solution and increase further to twelve times for oxygen saturation at dose-rates between 400 and 1,000 r./min. The most important characteristic, however, is that this reaction is a chain reaction with a very marked dependence upon dose-rate.

When the logarithm of G_s (number of sulphur atoms per 100 eV. of energy absorbed) for various dose-rates is plotted against the radiation dose, a family of curves results which have the following characteristics : there is an induction period during which the G_s values increase to a maximum and then remain constant when the radiation dose is further increased. Each dose-rate has its own maximum G_s value, which is the greater the slower the dose-rate (for example, 17,000 for 0·71 r./min.). The attainment of the maxima is shifted towards bigger doses with decreasing dose-rates. It is in practice scarcely possible to reach the maximum experimentally at very low dose-rates, because the radiation times required would be inconveniently long. The value of the maxima can, however, be satisfactorily extrapolated since the results for medium and higher dose-rates establish that G_s is nearly inversely proportional to the dose-rate (see Fig. 1).

The presence of oxygen is necessary for the chain reaction to occur. Lowering the oxygen tension from 100 per cent oxygen in the gaseous phase to 20 per cent causes a decrease of the G_s values but does not abolish the dose-rate effect. No after-effect of the irradiation has been observed.

The importance of this reaction, if other similar examples can be found, would appear to lie in the fact that the efficiency of ionizing radiations at very low dose-rates, as may occur with radioactive fall-outs, may be much greater than they are thought to be

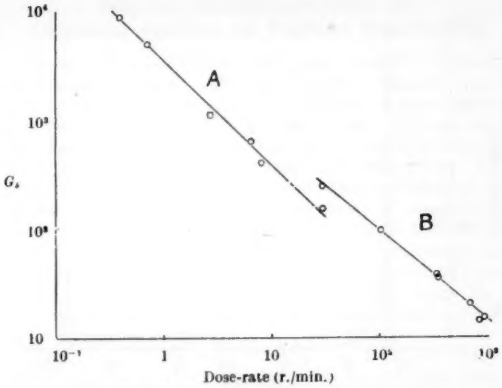

Fig. 1. Curves plotted for : (*A*) Total dose 10^4 r. before maximum G_s ; (*B*) total dose 3×10^3 r. at maximum G_s

at present. A short summary of part of the results of this investigation is in the course of publication in the proceedings of the International Conference on Radiobiology held in Cambridge (August 14–17, 1955), and a full account with experimental details will be published elsewhere.

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[1] Dale, W. M., *Brit. J. Radiol.*, Supp. No. 1, 46 (1947).
[2] Dale, W. M., Davies, J. V., and Meredith, W. J., *Brit. J. Cancer*, **3**, 31 (1949). Dale, W. M., and Davies, J. V., *Nature* **163** 64 (1949).

Rhythmic Biting Activity of Certain East African Mosquitoes

IN a recent communication in *Nature*, Corbet and Tjønneland[1] have described bimodal flight activity in East African Trichoptera, with peaks of activity just after sunset and before sunrise. A similar pattern is apparent in the biting cycle of various forest mosquitoes, and some years ago I introduced the term 'eo-crepuscular' to describe this type of activity[2].

In most of the more specialized mosquitoes the pattern of biting activity is repetitive from day to day and in addition many show a marked preference for a particular level, such as the forest canopy[3]. Though the biting cycles of most common species have now been studied in some detail, the reasons for these activity patterns are still, in many cases, not fully explained. It is therefore a matter of considerable interest to find a close correspondence between the biting cycle of a common mosquito, *Taeniorhynchus* (*Coquillettidia*) *fuscopennatus* Theo., and the flight rhythm of *Cheumatopsyche* sp. nov. as shown by Corbet, more particularly as the methods of capture were entirely different and as the cycle shown by the mosquito is related to biting activity, whereas the caddis fly probably feeds little if at all in adult life.

The results shown here for *T. fuscopennatus* (Fig. 1) are taken from a long series of 24-hr. catches now in progress in a patch of forest near Entebbe, Uganda, about sixty-five miles south-west of Corbet's catching station at Jinja. These catches of biting females are being carried out 65 ft. above ground, in the forest

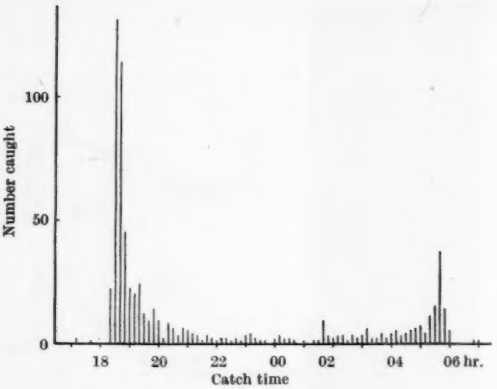

Fig. 1. Sunset at 18.00 hr.

canopy, with human bait, by methods described elsewhere[4]. The time of capture of each specimen is recorded to the nearest minute but, to permit comparison with Corbet's results, the figures have here been grouped by 10-min. periods. The sample under discussion was obtained in the twenty-five catches so far carried out, the number of *T. fuscopennatus* being 668. As the sunset period is most important in mosquito work and as the annual variation in sunset time is more than half an hour at Entebbe, Local Mean Time and East African Standard Time are not adequate for the work in hand. Instead, a special 'Catch Time' is used, this being accurately adjusted to the time of sunset, which is always recorded as 18.00 hr.[5]. In Corbet's communication East African Standard Time is given. It is found that on the evening of the catch he discusses (January 5, 1955) sunset occurred at Jinja at 18.56 ± 2, E.A.S.T. It is now seen that the first wave of activity in *T. fuscopennatus* reaches its peak in the third 10-min. period after sunset and in *Cheumatopsyche* in the fourth period. The sunrise peaks are similarly related to the period before sunrise. In both cases there is only ten minutes difference between the maximum for the mosquito and that for the caddis.

Corbet mentions that his study was concerned with the cyclical emergence of insects from Lake Victoria. It is not felt, however, that emergence cycles can have much effect on the biting-cycles of mosquitoes, as the females do not bite on the day of emergence, and many of them not until the third day of adult life. He also mentions that more intense reproductive activity at sunset may be the reason why the sunset peak is much larger than that at dawn. Elsewhere, Lumsden[5] has advanced the view that in mosquitoes with a double activity peak different age-grades may fly at different times, while Harker[6] has shown that, in the cockroach, activity rhythms may have a neurosecretory basis. I believe that in insects showing abrupt eo-crepuscular activity the control of this activity is mainly microclimatic.

The sudden nature of such activity peaks is well shown by the figures for *T. fuscopennatus*, where 37 per cent of the entire night catch was taken in the 20-min. period during 18.21–18.40 hr. The abruptness and short duration of the wave of activity suggest that a particular level of low light intensity may be important—it will be remembered that near the equator, as at Entebbe and Jinja, light intensity changes very rapidly indeed at dawn and sunset. Such an explanation is supported by current work on another mosquito, *Aedes* (*Finlaya*) *ingrami* Edw. This species reaches its peak of biting activity before sunset, and in this case the small peak at dawn occurs after, not before, sunrise. Under forest conditions in East Africa, the main climatic difference between dawn and sunset is in temperature. In both periods low light intensities prevail and in both saturation-deficiency is very low. While, however, sunset is a relatively warm period, dawn is the coldest period of the twenty-four hours[2,3]. This may be the main reason for the difference between the numbers taken biting at these times, as it is well known that in many species biting activity is reduced by low temperatures.

The complexity of mosquito biting cycles is not, however, fully indicated by catches confined to one level. Where catching goes on simultaneously at various levels, marked qualitative differences in the respective cycles may be found, as has been shown in *Anopheles* (*Myzomyia*) *gambiae* Giles[4]. Current work reveals a similar state of affairs in *T. fuscopennatus*. Broadly speaking, peaks of activity are shorter but more intense in the canopy than in the under-story, and in the under-story than at ground-level.

As Corbet was dealing with a very wide range of numbers, the scale of his histogram is of necessity logarithmic. Convenient though this scale may be, it does not bring out clearly the very abrupt nature of the peaks—nor the enormous quantitative difference between them. Deducing the arithmetical totals from his figure, it is found that the highest 10-min. period after sunset yielded more than twenty times as many insects as the highest dawn period. For this reason an arithmetical scale has been used in the present communication.

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[1] Corbet, P. S., and Tjønneland, A., *Nature*, **175**, 1122 (1955).
[2] Haddow, A. J., *Bull. Ent. Res.*, **36**, 33 (1945).
[3] Haddow, A. J., Gillett, J. D., and Highton, R. B., *Bull. Ent. Res.*, **37**, 301 (1947).
[4] Haddow, A. J., *Bull. Ent. Res.*, **45**, 199 (1954).
[5] Lumsden, W. H. R., *Bull. Ent. Res.*, **42**, 721 (1952).
[6] Harker, J. E., *Nature*, **173**, 689 (1954); **175**, 733 (1955).

Insecticide Resistance in *Anopheles gambiae* Giles

Although authenticated cases of physiological resistance to insecticides on the part of anopheline mosquitoes have been reported from Europe[1], North America[2] and the Far East[3], no such occurrence has so far been reported from Africa. The following preliminary observations appear to constitute a *prima facie* case of such resistance and it has therefore been considered desirable to place them on record.

In connexion with the Western Sokoto (Northern Nigeria) Malaria Control Pilot Project, an area of about 300 square miles has been set aside for treatment with dieldrin. In this zone are two large communities in which all houses have been treated as follows: Birnin Kebbi—two sprayings with dieldrin 50 per cent wettable powder at 25 mgm. dieldrin per sq. ft. followed by one at 50 mgm. per sq. ft.; Gwandu—three sprayings with the same insecticide at 25 mgm. per sq. ft.; all sprayings were at intervals of six months, commencing in June 1954.

Table 1

Place	Mosquito material	Toxicant	Concentration per cent	No. of mosquitoes exposed	Per cent mortality
Birnin Kebbi (dieldrin zone)	Bred from wild larvæ	Dieldrin	4·0	64	83
			2·0	62	45
			1·0	70	16
			0·5	61	5
Gwandu (dieldrin zone)	Wild-caught	Dieldrin	4·0	15	93
			2·0	15	60
			1·0	15	33
			0·5	15	20
Birnin Kebbi (dieldrin zone)	Bred from wild larvæ	DDT	4·0	15	100
			2·0	25	92
			1·6	16	31
			1·3	16	6
			1·0	20	5
			0·5	11	0
Argungu (unsprayed zone)	Wild-caught	Dieldrin	4·0	35	100*
			2·0	35	100*
			1·0	36	100*
			0·5	14	100†

* 100 per cent knocked down during 1 hr. exposure period.
† 57 per cent knocked down during 1 hr. exposure period.

The test for susceptibility to insecticides devised by Busvine and Nash[4] was applied to *A. gambiae* from these two towns in the dieldrin zone and from an unsprayed town about fifteen miles outside the sprayed area. These tests consisted of exposing fed *A. gambiae* females (eight wild-caught or bred from wild-caught larvæ) for 1 hr. to filter papers impregnated with a mixture of one part of toxicant solution in Risella oil and two parts of trichlorethylene, followed by a recovery period of 24 hr. Controls were run using Risella oil diluted as before but without dissolved toxicant, control mortalities being low. Results are given in Table 1.

The median lethal concentrations, estimated graphically, for the Birnin Kebbi material were: dieldrin, 2·0 per cent; DDT, 1·6 per cent. Comparable figures for the mosquitoes from the unsprayed Argungu area cannot be given, because all were killed by the lowest concentration used (0·5 per cent). However, in the following communication, Busvine gives median lethal concentrations for susceptible colonies of *A. gambiae*, as follows: dieldrin, 0·25 per cent; DDT, 0·95 per cent.

The difference in DDT-tolerance indicated by the figures 1·6 per cent and 0·95 per cent may not be significant, but the eight-fold difference in tolerance of dieldrin, while by no means as striking as some reported cases of insecticide resistance, is probably sufficient to enable the species to survive the control measures at present in force. It may be mentioned that houseflies from the same two towns, which returned to normal numbers in the sprayed zone after the first year of treatment, have shown a seven-fold increase in their tolerance of dieldrin.

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[1] Lividas, G. A, and Georgopoulos, G., *Bull. WHO.*, **8**, 497 (1953).
[2] Kruse, C., Hawkins, W., and Ludvik, G., *J. Econ. Entom.*, **45**, 810 (1952).
[3] Crandell, *Mosquito News*, **14**, 194 (1954).
[4] Busvine, J. R., and Nash, R., *Bull. Entom. Res.*, **44**, 371 (1953).

Normal Resistance-levels of *Anopheles gambiae* to Various Insecticides

In several areas where large-scale residual spraying programmes have been undertaken against mosquitoes, some increase in their resistance to insecticides has been suspected after a year or two. Unless the increase is very great, it is not easy to establish from field-observations, which may be influenced by seasonal variations and, possibly, the inefficiency of operators. Laboratory comparisons of specimens from sprayed and unsprayed areas are desirable; but very little is known of natural variations in resistance of any species in different localities. There is much to be said, therefore, for preliminary determination of resistance-levels before undertaking large spraying campaigns.

This communication records some preliminary results on the normal resistance of the African mosquito *Anopheles gambiae*. The method of measurement was introduced by Busvine and Nash[1], but is more fully described in an annex to the Fifth Report of the World Health Organization Expert Committee on Malaria[2]. Two strains of *A. gambiae* were used, both of which had been reared for a number of generations in the laboratories of the Ross Institute in London, as mentioned by Wall[3]. One was a West African colony from Lagos, Nigeria, which had been reared for about twenty generations in captivity. The other had been obtained from Tengeni, Tanganyika, and reared in London for about five generations. The mosquitoes were reared at 27° C. and tested at the same temperature, a few hours after a blood meal.

Tests were carried out with each insecticide on four different days, over a period covering about three generations of the mosquitoes. On each occasion, about three replicates of five mosquitoes were exposed at each concentration tested. When the results were carefully examined, it was evident that there was no appreciable difference between the two strains in resistance to DDT or gamma BHC, so the results were combined. Only the West African strain was used in the tests with dieldrin. The results, corrected for the overall control mortality (8 per cent), were as follow:

Per cent DDT	2	1	0·75	0·5
Per cent kill	91	53	34	13
Per cent gamma BHC	0·06	0·03	0·02	0·01
Per cent kill	100	96	74	24
Per cent dieldrin	0·45	0·40	0·30	0·20
Per cent kill	100	95	59	29

Logarithms of concentration/probit mortality regression lines were drawn to these results, and the following median lethal concentrations were estimated visually: DDT, 0·95 per cent; gamma BHC, 0·015 per cent; dieldrin, 0·25 per cent.

Mr. J. G. Halcrow kindly allows me to quote some comparable results which he obtained in unsprayed areas of Mauritius in 1954, using the same method, with adults which emerged from larvæ collected in the field:

Per cent DDT	2	1	0·5
Per cent kill	100	75	41
Per cent dieldrin	0·5	0·3	0·2
Per cent kill	100	64	28

These figures indicate a slightly greater susceptibility to DDT (median lethal concentration, 0·7 per

cent), but the resistance to dieldrin was identical with that of the laboratory colonies in London.

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[1] Busvine, J. R., and Nash, R., *Bull. Entom. Res.*, **44**, 371 (1953).
[2] World Health Organization Tech. Series Report No. 80 (1954).
[3] Wall, W. J., *Trans. Roy. Soc. Trop. Med. Hyg.*, **47**, 268 (1953).

So-called 'Glacier-Worms' in New Zealand

Some years ago, during an expedition to the St. Elias Mountains on the Alaska–Yukon boundary, I found some oligochaetous annelids, which are known to occur throughout the western coastal ranges of North America, and are usually referred to as 'glacier-worms' or 'ice-worms'[1]. In my report of this find I asked for any information that might be available upon the occurrence and distribution in general of species of the particular genus, *Mesenchytraeus*, to which these worms belong. However, not a single reply has since been received in answer to that inquiry.

Soon after coming to New Zealand in 1950, I heard that on the Franz Josef Glacier, Westland, small insects, which simulated worms, had been seen in the ice. Indeed, these creatures, and also spiders, had been reported by the pioneer surveyors, C. Douglas and A. P. Harper, in the early 1890's[2,3]. Having failed to find any of these insects myself during one or two visits to this glacier, I was very gratified recently to receive from Mr. R. J. Warburton of Waiho, Westland, several specimens which he had collected and preserved in spirit. Through the kindness of Dr. G. H. Satchell, of the Department of Zoology, University of Otago, these have now been identified, not as worms, but as larvæ, pupæ and one adult, of some species of chironomid fly. Moreover, as Dr. Satchell has remarked, it was only the presence together of larvæ and adult that made identification possible. The family Chironomidae has scarcely been studied at all in New Zealand, only a fraction of the species having as yet been described. Known colloquially as the 'Harlequin fly', they are, it seems, almost ubiquitous, chironomid larvæ being taken from such varied environments as hot springs, from the bottoms of deep lakes, from soil, from dung and from many other moist habitats. Yet here is one which selects glacier ice and melt-water for its temporary home. Douglas[2] had described the "small, worm-like things" as from a sixteenth to an eighth of an inch in length, very active, and when chased tending to dive into the almost invisible holes in the honeycombed ice. In considering them probably to be larvæ he anticipated modern determination.

The specimens kindly sent me by Mr. Warburton were found in small streams of melt-water in the centre of the glacier, either in the water itself or in the actual ice forming the bed and banks of the streams; but the majority of the larvæ were dug out of the ice, while the adult stage, the fly, was found crawling on the ice in the vicinity of the 'worms'. Most specimens seem to be more prevalent in streams which flow through comparatively clean ice. The largest 'colony' which Mr. Warburton came across was at the foot of the main ice fall of the Franz Josef Glacier at about 3,400 ft. Here there were literally hundreds of them in the ice in the bed of melt-water streams, although at the time (9 a.m.) the latter were scarcely flowing owing to the frost. Later, when the volume of water had increased, the 'colony' was found to be greatly reduced in numbers. In fact, it would seem that these creatures must have quite a precarious existence, for increase in volume of water, either from melting or rain (in a district of very high precipitation), must wash away the majority of them. They have not so far been discovered on the neighbouring Fox Glacier, nor on other glaciers of the Southern Alps: and their altitudinal range, on the Franz Josef Glacier, seems to be between about 1,400 ft. and 3,400 ft. The larvæ have been found active in dull weather and in sunshine, and at various hours between 9 a.m. and 3 p.m., from summer through autumn to winter, namely, January to June.

There would certainly seem to be ample scope for further study of this interesting species, and stage of development, of this chironomid fly: not even a name is as yet available for it.

Since I am about to return to England, any correspondence arising out of the above subject should be addressed to me, c/o Clare College, Cambridge.

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[1] Odell, N. E., *Nature*, **164**, 1098 (1949); **165**, 337 (1950).
[2] Douglas, C., Appendix 6, *J. House of Representatives* (*N.Z.*), C.1, 72 (1894).
[3] Harper, A. P., "Pioneer Work in the Alps of New Zealand", 267 (1896).

Maintenance of Adult Mosquito Tissue in a Tissue-Culture Medium

A series of experiments to be reported elsewhere has been performed to discover the nature of egg development in adult female mosquitoes. In the course of the work, a tissue-culture medium was used for suspending extirpated ovaries in various stages of development. This was done to see if development of the isolated ovaries could be induced or continued.

The anautogenous species used were *Aedes hexodontus* Dyar and *Aedes aegypti* (Linnaeus). *Aedes communis* (De Geer), a species of mosquito autogenous in the Churchill, Manitoba, region[1], was also used.

The ovaries were removed from the insects using a sterile technique in the following manner. The adult female mosquito was surface-sterilized by immersion for 2 min. in a 0·5 per cent solution of mercuric chloride in 50 per cent ethyl alcohol. The surface-sterilized insect was transferred to insect Ringer solution[2] and the last abdominal segment grasped with a pair of fine jeweller's forceps, while the thorax and upper abdomen were held with another pair of forceps. The genitalia, spermathecæ, ovaries and gut of the mosquito were stretched from the rest of the abdomen by steadily pulling on the last segment. The ovaries were then broken away from the vagina and separated from the insect. They were placed in a drop of tissue-culture medium on a polished, sterile, cover glass, and this cover glass was inverted over a deep depression slide. Finally, the cover glass was fastened to the slide with hot melted paraffin.

The chemically defined tissue-culture medium was the improved *M*199, now called *M*150, developed by Morgan[3]. This medium is similar to that used for growing monkey kidney for polio vaccine research. In *M*150 the muscle tissue of the ovaries of *Aedes hexodontus* and *Aedes communis* showed contraction for as long as seven days, but no egg development was noted. The muscle tissue of *Aedes aegypti* showed contraction for as long as sixty days in *M*150, but again no development of the ovaries took place. Controls of insect Ringer solution and of *Polyphemus* (Lepidoptera), and *Cynthia* (Lepidoptera) blood permitted muscle movement only for from two to three days; there was no development of the ovaries. No sign of mitosis was noted in any of the tissue-culture preparations, but some migration of the strands of tissue attached to the ovaries was noted along the polished glass surface.

Dr. J. F. Morgan, National Health and Welfare Laboratory, Ottawa, Canada, supplied the tissue-culture medium; Dr. H. A. Schneideman, Department of Zoology, Cornell University, supplied the Lepidoptera blood. The interest and advice of both these colleagues were most helpful.

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[1] Beckel, W. E., *Mos. News*, **14**, (3), 124 (1954).
[2] Ephrussi, B., and Beadle, G. W., *Amer. Nat.*, **70**, 218 (1936).
[3] Morgan, J. F. (personal communication). Morgan, J. F., Morton, H. J., and Parker, R. C., *Proc. Soc. Exp. Biol. Med.*, **73**, 1 (1950). Morgan, J. F., Campbell, M. E., and Morton, H. J., *J. Nat. Cancer Inst.* (October 1955).

Polymorphism of Alkyl Sulphate Soaps

Alkyl sulphate soaps $NaSO_4C_nH_{2n+1}$, like the fatty acids and alcohols, may be expected to have a tendency to join together the hydrophylic groups of neighbouring molecules. In the crystalline state, this tendency will lead to sheets of double molecules with stretched chains more or less perpendicular to the sheets. We have measured the corresponding long spacing, using the classical method of copper $K\alpha$ reflexion, at a thin layer of soap on a glass slide, the distance plate to axis in the Muller camera being 10 cm. During the investigation, we saw a paper by Rawlings and Lingafelter[1], who made a complete determination of the unit cells. They found different modifications, the α-form with the smallest water content being the most stable. We have also found this α-modification. Moreover, we succeeded in making all our substances crystallize completely in this modification. This proves the chemical homogeneity (within some per cent) of our substances and their identity with Rawlings and Lingafelter's substances. As we have, however, also found a number of rather stable modifications not mentioned by them, we give here a short account of our procedure.

All our preparations were handled at room temperature in one of the following ways: (*a*) Taking the flaky crystals from the bulk material and pressing or smearing them on the glass slide. In Table 1 the solvent used at the last purification of the bulk material, usually not at room temperature, is given, except for the material from Du Pont, which we did not know. (*b*) Dissolving the crystals in various solvents and evaporating the clear solutions on a glass slide at room temperature. (*c*) Soaking crushed crystals for about an hour in more or less saturated solutions, finally smearing them on the slide. (*d*) Putting the crystals on a slide and wetting them with a drop of solvent in such a way that a superposition of the preceding two cases occurs. (*e*) A subsequent heat treatment was sometimes given by putting the slide in a simple thermostat for some time as indicated in the table.

The X-ray exposure took 5–50 min., the angle of incidence varying continuously from 0° to 12° (or 2° to 6°). Fig. 1 gives an idea of the photographs on which the table is based. The first three orders were always by far the strongest. Of the succeeding orders, either the fourth and fifth or the sixth (and eighth) were the strongest; this is indicated in the table by the signs * and † respectively against the spacing. It is rather difficult to make the surface of the soap and not that of the glass slide coincide with the axis of rotation. A correction was sometimes applied for this.

The columns of Table 1 indicate twelve modifications not given by Rawlings and Lingafelter. With C_8- and C_9-soaps we have found only the α-modification (28·5 and 31·0 A.). In the case of C_{12}-soaps, in

Table 1. Different Long Spacings indicating as Many Different Modifications of Crystalline Sodium Alkylsulphate Soaps
Spacings in A. at room temperature. w = weak. For * and † and other signs see text.

a	*p*	*q*	*r*	*s*	*t*	
			C_{10}			
—	45·0*	—	38·3†	—	—	(1) like (21) (*a*)
—	—	—	38·25†	—	—	(2) from ethanol (*b*)
47·3*	—	—	—	39·0*	—	(3)=(2) 2 hr. at 60° (*e*)
47·5	—	—	—	39·2*	—	(4)=(3) ,, ,, 70° (*e*)
47·5	—	41·8 (w)	38·4	—	—	(5) from acetone (*b*)
47·3	44·8*	—	—	39·3*	—	(6) soaked in acetone (*c*)
—	44·9	—	38·4†	—	35·3*	(7) with water (*d*)
			C_{14}			
43·25*	—	—	—	—		(8) Du Pont (*a*)
43·0 (w)	—	—	34·5†	—		(9) ,, from ethanol (*b*)
—	—	—	34·4†	33·6*		(10) ,, from water (*b*)
—	—	—	34·5†	33·8*		(11) this lab. ,, (*b*)
43·1	—	—	—	33·8* (w)		(12)=(11) 30 min. at 65° (same 6 hr.) (*e*)
43·0	—	35·6	—	33·9		(13)=(12) 1 hr. at 85° (*e*)
43·1 (w)	36·5	—	34·7†	—		(14) this lab. from acetone (*b*)
43·2	37·3	—	34·7†	—		(15) Du Pont ,, ,, (*b*)
43·0	—	35·5 (w)	—	—		(16)=(15) at 70° (same as (14) (*e*)
43·0	—	35·3	34·5†	—		(17)=(11) soaked in acetone (*c*)
43·0	—	—	34·5†	—		(18) Du Pont soaked in acetone (*c*)
43·0	—	35·5 (w)	—	—		(19)=(17) at 80° (*e*)
43·0	—	—	—	—		(20)=(18) at 80° (*e*)
			C_{16}			
33·8†	30·8 (w)	28·0†	27·2			(21) from butanol, then rinsed with ether (*a*)
33·9	30·3 (w)	27·9	27·2			(22) like (21)
33·9	30·3 (w)	28·0	—			(23)=(22) 4 hr. at 75° (*e*)
33·9	29·6 (w)	27·7	26·9 (w)			(24) from ethanol (*b*)
33·9	—	—	—			(25) from acetone (*b*) (same soaked *e*)
33·9	—	—	—			(26) from water (*b*)

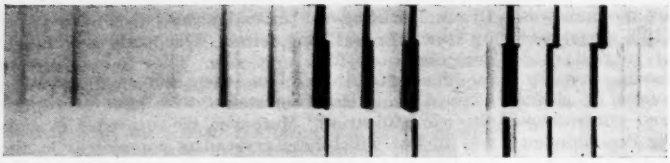

Fig. 1. Reflexion spectra of three layers of C_{16}-soap, marked (1), (3) and (4) in the table. All spectra have been taken on the same plate to allow a better comparison. In the centre left-hand part, the spectra of (1) and (4) have been superposed. The complete correspondence is :

	Left-hand	Right-hand
Upper part	(1)	(1)
Middle part	(1)+(4)	(4)
Lower part	(3)	(3)

Notice the strength of the first three orders and the blurred appearance of the lines of a smeared preparation (1) compared with preparations (3) and (4) crystallized on the slide

addition to the α-modification (38·5 A.) we got a new modification with $d = 32{\cdot}8$ A. The search in these three cases has, however, not been as exhaustive as with C_{10}-, C_{14}- and C_{16}-soaps.

The different modifications are most probably connected with differences in tilt of the chains and number of water molecules added to the hydrophilic groups. It is less probable that an appreciable number of other solvent molecules were bound, as the same modifications arose from different solvents, which on the other hand always contained some water. It is curious that at room temperature all the modifications found are (meta)stable, as is proved by the constancy of their X-ray diffraction pattern after many days. Another curious fact (see Table 1) is that soaking sometimes has as much effect as recrystallizing : (11), (14), (17) and (21), (25). This may have useful applications.

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[1] Rawlings, F. F., and Lingafelter, E. C., *J. Amer. Chem. Soc.*, **77**, 870 (1955).

Low Audio-frequency Electromagnetic Signals of Natural Origin

Natural electromagnetic signals of very low frequency have been studied by several investigators during the past few years. In 1948 Willis[1] reported a series of measurements of 'magnetic noise' in the frequency-range 5–800 cycles/sec. but did not discuss the problem of the physical origin of the observed signals. That some of the signals reported by Willis are due to lightning is strongly indicated by observations of other investigators[2]. Aarons and Henissart[3], working in the frequency-range 1–20 cycles/sec., have reported correlations between low-frequency magnetic fluctuations and geomagnetic disturbance and solar phenomena. Therefore it appears that in the frequency-range 1–100 cycles/sec. there is a transition in the dominant physical cause of natural electromagnetic signals.

More than a year ago, we undertook a programme of measurement of natural electromagnetic signals in the audio-frequency range 25–130 cycles/sec. with the view of gathering evidence concerning their physical origin. In March and April of 1954, measurements in the frequency range 10,000–25 cycles/sec., conducted jointly with L. Liebermann of the University of California at La Jolla, established that a large number of signals at less than 130 cycles/sec. were accompanied by a high-frequency component with characteristic atmospheric wave-form, and presumably were produced by lightning discharges.

Subsequent to the joint tests, equipment for measuring low-frequency signals has been maintained by one of us (O. E. D.) in the Borrego Valley of Southern California at lat. 33° 25′ N. and long. 116° 20′ W. At this remote desert location, interference due to artificial signals from electromagnetic devices and power-lines was negligible. Both air-core coils and a vertical antenna have been used for detecting the signals. In both cases the half-power points of the overall system (detecting element and amplifier) were at 25 and 130 cycles/sec. While oscillographic recording has been used for examining signal wave-form, it was expedient to employ a rectifier, smoothing circuit, and pen recorder in the study of the temporal variation of the mean signal amplitude over long intervals, of the order of months.

The mean signal amplitude in the months of March and April exhibited a fairly regular diurnal oscillation which was strikingly similar in amplitude and phase to the diurnal variation of the atmospheric electrical potential gradient measured at sea. Fig. 1 presents the mean diurnal oscillation of the electromagnetic signal amplitude during 14 days in March and April and the mean diurnal oscillation of the potential gradient measured during the months of February, March and April on Cruise VII of the *Carnegie*[4]. Similar correspondence between the two diurnal oscillations was found during the fall months. The maximum ordinates of each curve lie between 14 and 21 hr. universal time. In precisely this interval it is mid-afternoon successively in Central Africa and in the Amazon Valley when these principal world thunderstorm centres reach their peak activity.

The diurnal oscillation of the low-frequency signal amplitude is quite different during the summer

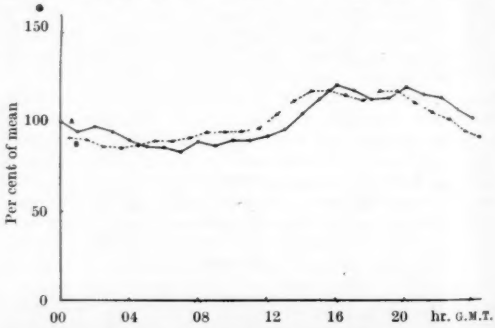

Fig. 1. Mean diurnal variation of (*A*) low-frequency signal amplitude, Borrego Valley, March and April 1954, and (*B*) potential gradient at sea, February, March and April 1929

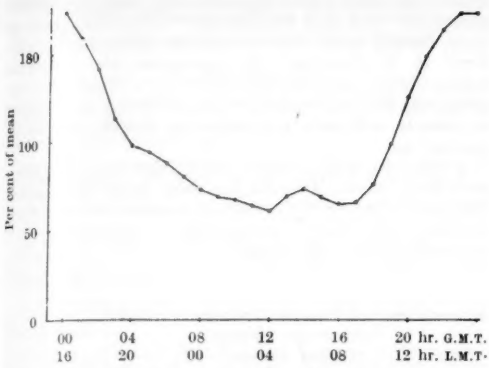

Fig. 2. Mean diurnal variation of low-frequency signal amplitude, Borrego Valley, August 1954

months, as shown in Fig. 2. Between 10 and 24 hr. local (120th meridian) time the amplitude is much larger than during the corresponding hours in spring and autumn, reaching a value about three times as great at 16 hr. local time. The interval of large signal amplitude corresponds to the time of greatest thunderstorm activity on the North American continent, within 35° of the observing station.

It is well known that the electrical potential gradient at sea executes a regular diurnal oscillation on universal time. The observation is usually interpreted as an indication of world-wide thunderstorm activity, on the hypothesis that thunderstorms supply an upward current to the ionosphere which leaks back to the earth in all regions away from the immediate vicinity of the storms. Over the oceans where the atmospheric conductivity varies only a few per cent during an undisturbed day, the potential gradient is nearly proportional to the leakage current density and, hence, approximately proportional to the number of thunderstorms in progress over the world. The implication of the correlation shown in Fig. 1 is that the mean amplitude of the low-frequency electromagnetic signal is also an approximate measure of world thunderstorm activity.

The most surprising feature of the implication lies in the fact that the two principal thunderstorm centres in South America and Africa are respectively 65° and 135° from Borrego Valley; hence, the amplitude of the signals from these centres might be expected to differ significantly. The apparent anomaly finds a plausible explanation if one assumes that the signal power is confined by the spherical wave-guide formed by the earth and ionosphere, and that to a first approximation at very low frequencies one may neglect the differences between signal attenuation over daylight and dark paths. In these circumstances the signal power would vary with angular distance, θ, from the source as $\exp(-\alpha\theta)/\sin\theta$. Assuming the attenuation constant, α, to be of the order of 1/60 deg.$^{-1}$ and taking account of the signal propagation over both the long and short great-circle paths, one finds that the mean signal power from similar sources between 70° and 150° from the observing station varies by less than a factor of 2. Thus, if there is no extensive thunderstorm activity close to the observing station, the mean signal amplitude should be roughly proportional to the number of storms in progress.

While the results presented here are not in themselves conclusive evidence, they strongly suggest that the majority of the electromagnetic signals between 25 and 130 cycles/sec. are atmospherics. Further, the signals in this frequency-range appear to have a sufficiently low attenuation to suggest that they are received from lightning in all parts of the world. In the case of properly selected observing sites, remote from large thunderstorm centres, the mean signal amplitude is roughly proportional to the number of storms in progress. Thus, it appears possible that an index of world thunderstorm activity may be obtained from one or a very small number of carefully selected low-frequency stations.

The measurements reported here have been continued and supplemented by additional measurements. A more complete account will be published elsewhere.

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[1] Willis, H., *Nature*, **161**, 887 (1948).
[2] Watson-Watt, R. A., Herd, J. F., and Lutkin, F. E., *Proc. Roy. Soc.*, A, **162**, 267 (1937). Hepburn, F., and Pierce, E. T., *Nature*, **171**, 837 (1953). Chapman, F. W., and Matthews, W. D., *Nature*, **172**, 495 (1953).
[3] Aarons, J., and Henissart, M., *Nature*, **172**, 682 (1953).
[4] Torreson, O. W., Gish, O. H., Parkinson, W. C., and Wait, G. R., Scientific Results of Cruise VII of the *Carnegie*, Carnegie Institution of Washington, Pub. 568 (1946).

Trinuclear Molecules in the Crystal Structure of Bisacetylacetonenickel(II)

The stereochemistry of four-covalent nickel(II) complexes has been a subject of great interest to chemists for the past two decades. Following the enunciation of Pauling's theories relating stereochemistry, bonding orbitals and magnetic moment, it has been shown that, in all cases where structural studies have been carried out, the diamagnetic four-covalent complexes of nickel(II) are square planar[1]. However, little work has been done to investigate the structure of the paramagnetic (presumably) four-covalent complexes such as bissalicylaldehydenickel(II) and bisacetylacetonenickel(II). These complexes have a magnetic moment indicating two unpaired electrons[2] and usually this has been assumed, without proof, to indicate that $4s4p^3$ tetrahedral bonding occurs. It has been shown by Curtiss, Lyle and Lingafelter[3] that the X-ray powder patterns of bissalicylaldehydenickel(II) and of its zinc analogue are identical. This has been taken as evidence in support of a tetrahedral arrangement of the four oxygen atoms around the nickel(II) atom because zinc(II) is known to display tetrahedral co-ordination. However, in the absence of definite proof that the zinc(II) atom has tetrahedral co-ordination in this instance, the case is not proved. It was decided, therefore, to carry out an X-ray investigation of bisacetylacetonenickel(II) and the preliminary results are summarized here.

Crystals of bisacetylacetonenickel(II), prepared by sublimation under reduced pressure, were found to be orthorhombic with $a = 15{\cdot}65 \pm 0{\cdot}02$ A., $b = 23{\cdot}23 \pm 0{\cdot}04$ A., $c = 9{\cdot}64 \pm 0{\cdot}02$ A. Absent spectra are: $(h0l)$ when h is odd and $(hk0)$ when k is odd. These absences show the space group to be either $Pmab$ or $P2_1ab$. Tests for pyroelectricity and piezoelectricity were negative, and a statistical survey of the intensities of the $(h0l)$ and $(hk0)$ zones by the

procedure of Howells, Phillips and Rogers[4] did not give a conclusive result which would enable a choice between the two space groups to be made. The density of the crystals is $1{\cdot}455 \pm 0{\cdot}001$ gm./ml. and the number of formula units $Ni(C_5H_7O_2)_2$ in the unit cell is 12 (calculated $11{\cdot}96 \pm 0{\cdot}07$).

Examination of the three-dimensional Patterson function and, in particular, of Patterson–Harker sections, showed that there are three nickel atoms in the asymmetric unit, the space group being $P2_1ab$. The co-ordinates of these three nickels are given in Table 1; the three atoms are very nearly collinear and the distances between adjacent atoms are: $Ni_1 - Ni_2$, 2·72 A., and $Ni_2 - Ni_3$, 2·88 A.

Table 1. Co-ordinates as Fractions of the Axial Lengths

Atom	x	y	z
Ni_1	0·092	0·036	0·256
Ni_2	0·000	0·120	0·125
Ni_3	−0·098	0·208	−0·017

It is considered that, at the stage to which this work has been taken, the difference between these two values is not significant. The proximity of the nickel atoms implies either (*a*) an interaction between neighbouring nickels, or (*b*) a bridging of neighbouring nickels by other atoms. In either case the crystal must contain large molecules, each three times as big as hitherto supposed, namely, $Ni_3(C_5H_7O_2)_6$. The presence of these trinuclear molecules is shown plainly in the electron density projection on (001), $\rho(xy0)$, reproduced in Fig. 1. Direct and 'trial and error' methods of determining the positions of the other atoms have failed to lead to a unique solution. Many possible molecular models can be ruled out, but with trinuclear molecules the possibility of octahedral co-ordination of the nickel atoms must be taken into account; it is not simply a choice between tetrahedral and square-planar co-ordination.

It is apparent that further investigation of this compound using other physical techniques is essential before one can decide between the various possible structures with any confidence. With this object in view, further work is proceeding in collaboration with Prof. R. S. Nyholm. In particular, the magnetic susceptibility is being studied over a range of temperature, the molecular weight is being determined in various solvents and infra-red studies are to be carried out.

I wish to thank both Dame Kathleen Lonsdale and Prof. R. S. Nyholm for their help and advice. The award by the University of London of the Arthur Jubber and other postgraduate studentships is acknowledged with thanks.

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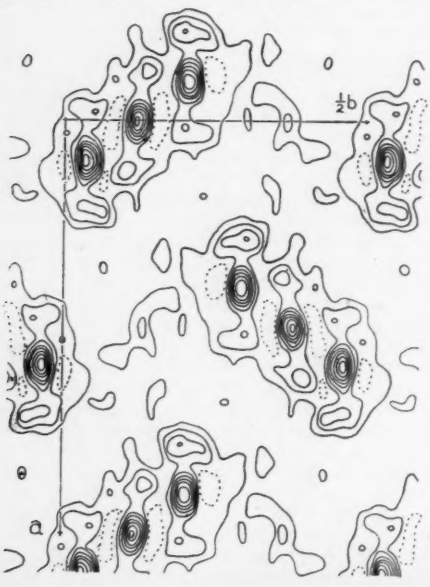

Fig. 1. Electron-density projection on (001). Contour interval arbitrary, some contours around the nickel atoms being omitted for clarity

[1] See, for example, Godycki, L. E., and Rundle, R. E., *Acta Cryst.*, **6**, 487 (1953). Cox, E. G., Wardlaw, W., and Webster, K. C., *J. Chem. Soc*, 1475 (1935).

[2] Mellor, D. P., and Craig, D. P., *J. Proc. Roy. Soc., N.S.W.*, 74, 475 (1940).

[3] Curtiss, D. H., Lyle, F. K. C., and Lingafelter, E. C., *Acta Cryst.*, **5**, 388 (1952).

[4] Howells, E. R., Phillips, D. C., and Rogers, D., *Acta Cryst.*, 3, 210 (1950).

The Arrow of Time

It is widely believed that all irreversible mechanical processes involve an increase of entropy, and that 'classical' (that is, non-statistical) mechanics, of continuous media as well as of particles, can describe physical processes only in so far as they are reversible in time[1]. This means that a film taken of a classical process should be reversible, in the sense that, if put into a projector with the last picture first, it should again yield a possible classical process.

This is a myth, however, as a trivial counter-example will show. Suppose a film is taken of a large surface of water initially at rest into which a stone is dropped. The reversed film will show contracting circular waves of increasing amplitude. Moreover, immediately behind the highest wave crest, a circular region of undisturbed water will close in towards the centre. This cannot be regarded as a possible classical process. (It would demand a vast number of distant coherent generators of waves the co-ordination of which, to be explicable, would have to be shown, in the film, as originating from one centre. This, however, raises precisely the same difficulty again, if we try to reverse the amended film.)

Thus irreversible classical processes exist. (On the other hand, in statistical mechanics all processes are, in principle, reversible, even if the reversion is highly improbable.) Although the arrow of time is not implied by the fundamental equations, it nevertheless characterizes most solutions. For example, in applying Maxwell's theory, the initial conditions determine whether we choose to work with retarded or with advanced potentials, and the resulting situation is, in general, irreversible.

K. R. Popper

University of London.
Nov. 30.

[1] See, for example, Max Born, "Natural Philosophy of Cause and Chance", especially pp. 25f. (1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 19

UNIVERSITY OF LONDON (at Birkbeck College, Malet Street, London, W.C.1), at 4.15 p.m.—Prof. Y. Cauchois (Paris): "The Present State of X-Ray Spectroscopy and its Application to the Study of Solids".* (Further lectures on March 20 and 21.)

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Informal evening on "Electronics and Automation". Dr. H. A. Thomas: "Some Industrial Applications" (with films and demonstrations).

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP and AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. E. J. Miller: "Toxic Chemicals in Foodstuffs".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. J. T. Scales: "Biomechanical Problems in Orthopædics".*

INSTITUTE OF METAL FINISHING (at Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Dr. T. P. Hoar: "Some Problems in Bright Plating".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Prof. O. H. K. Spate: "Problems of Development in New Guinea".

Tuesday, March 20

INSTITUTION OF CHEMICAL ENGINEERS (in conjunction with the BRITISH NUCLEAR ENERGY CONFERENCE at the Royal Institution, Albemarle Street, London, W.1), at 5.30 p.m.—Mr. C. M. Nicholls, Mr. J. B. Morris and Mr. F. W. Fenning: "The Application of Fluidization Techniques to Nuclear Reactors".

SCIENTIFIC FILM ASSOCIATION (in the Mezzanine Cinema, Shell-Mex House, Strand, London, W.C.2), at 6.30 p.m.—Meeting on "The Making of Research Films".*

INSTITUTION OF MECHANICAL ENGINEERS, EDUCATION GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "The Use of Pictures and Other Graphical Methods in Teaching Engineering".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. P. T. Fink: "Experiments on Flow Over Swept Back Wings".

Tuesday, March 20—Thursday, March 22

INSTITUTION OF NAVAL ARCHITECTS (in the Weir Lecture Hall, 10 Upper Belgrave Street, London, S.W.1), at 10 a.m. daily—Spring Meeting.

Tuesday, March 20

At 10 a.m.—Annual General Meeting.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at the Royal Horticultural Society's New Hall, Greycoat and Elverton Streets, London, S.W.1)—Eighth Technical Exhibition.*

Wednesday, March 21

INSTITUTE OF BIOLOGY, LONDON BRANCH; ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION; INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at the Senate House, University of London, London, W.C.1), at 5 p.m.—Joint Symposium on "The Presentation of Science to the Public".

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Meeting on "Developments of the Decca Navigator System".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. J. K. Bannon and Mr. A. Gilchrist: "Variations of Temperature in the Troposphere and Lower Stratosphere"; Mr. E. B. Kraus: (*a*) "Secular Changes of Tropical Rainfall Regimes", (*b*) "Secular Variations of East-Coast Rainfall Regimes".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. R. H. S. Phillips: "United Kingdom Indices of Wholesale Prices 1949–55".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. James H. Renwick: "Linkage in Human Genetics".*

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. P. J. Jackson and Mr. J. M. Ward: "Operational Studies of the Relationship between Coal Constituents and Boiler Fouling"; Mr. A. M. Freedman: "Full-scale Trials of the Humidification of Combustion Air to Prevent Boiler Fouling"; Mr. B. Lees: "An Investigation into the Air-heater Corrosion of Oil-fired Boilers".*

ROYAL INSTITUTION, LIBRARY CIRCLE (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. K. D. C. Vernon: "Finding the Answer".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. E. S. Horning: "Some Anomalies in Endocrine Carcinogenesis".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. J. H. Askew: "A Novel Relay Amplifier".

BRITISH PSYCHOLOGICAL SOCIETY, MEDICAL SECTION (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 8.30 p.m.—Prof. H. J. Eysenck: "Psychological Theories and Psychiatric Practice".

Thursday, March 22

MINISTRY OF EDUCATION (joint meeting with the BRITISH ASSOCIATION FOR COMMERCIAL AND INDUSTRIAL EDUCATION, at the Royal Festival Hall, South Bank, London, S.E.1), at 10.30 a.m.—Conference on "The Development of Sandwich Courses".

BIOCHEMICAL SOCIETY (at University College, Gower Street, London, W.C.1), at 10.45 a.m.—Annual General Meeting followed by Scientific Papers.

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 3 p.m.—Annual General Meeting and Symposium on "Loudspeakers". Lecturers: Dr. D. M. Tombs, Mr. P. J. Walker, Mr. F. H. Brittain and Mr. S. Kelly.

MINERALOGICAL SOCIETY (at the Royal Entomological Society, 41 Queen's Gate, South Kensington, London, S.W.7), at 5 p.m.—General Meeting.

INSTITUTE OF REFRIGERATION (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. R. F. Brown: "Thermodynamic Calculations for Programme Control of a Test Chamber".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at 16 Princes Gate, South Kensington, London, S.W.7), at 7 p.m.—Mr. F. Pollak: "Masking for Half-Tone".

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Electrical Lecture Room, University College, Gower Street, London, W.C.1), at 7.30 p.m.—Dr. M. R. A. Chance: "The Role of Sexuality in the Social Life of Monkeys" (Film and Paper illustrated by slides).

Thursday, March 22—Friday, March 23

INSTITUTION OF MINING AND METALLURGY (in the Lecture Hall of the Royal Society of Arts, 6 John Adam Street, Adelphi, London, W.C.2)—Symposium on "The Extraction Metallurgy of Some of the Less Common Metals".

Friday, March 23

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Discussion of Papers of Geophysical Interest. Chairman: Mr. B. C. Browne. Speakers: Dr. A. H. Cook, Dr. D. I. Gough, Dr. E. R. Lapwood and Dr. E. R. Niblett.

ROYAL MICROSCOPICAL SOCIETY (in the New Chemistry Building, King's College, Newcastle-upon-Tyne), at 6 p.m.—Dr. J. R. G. Bradfield: "Electron Microscopical Contributions to the Study of Living Matter".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. P. M. S. Blackett, F.R.S.: "Rock Magnetism and the Movement of Continents".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN BIOLOGICAL CHEMISTRY—The Secretary, The University, Aberdeen (March 24).

LECTURER (with special qualifications in physical chemistry or inorganic chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (March 24).

CHEMIST or CHEMICAL ENGINEER (with an honours degree in chemistry or chemical engineering or equivalent qualifications, and preferably with operational research experience in the chemical, metallurgical, or fuel industries) IN THE PRODUCTION CONTROL SECTION of the Operations Branch, for duties which include liaison with works managerial staff on production problems, the analysis of operational data, the planning of programmes and the co-ordination of research and development concerned with existing plants and processes—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, quoting Ref. 1319 (March 26).

LECTURER (man or woman, with suitable qualifications in physics) IN SCIENCE, to assist in General Science Courses (including a Supplementary Course for serving teachers)—The Principal, City of Leeds Training College, Beckett Park, Leeds 6 (March 26).

LECTURER (with experience in either experimental or theoretical physics) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Liverpool (March 29).

PRINCIPAL SCIENTIFIC OFFICER (with at least a second-class honours degree in metallurgy or equivalent qualification, a good background in the engineering uses of the well-known metals and alloys, and a thorough understanding of modern theories of physical metallurgy) IN THE RESEARCH AND DEVELOPMENT BRANCH, U.K.A.E.A., Springfields Works, Salwick, near Preston, Lancashire, to direct a section engaged in physical metallurgy and metallography—The Recruitment Officer, United Kingdom Atomic Energy Authority, Industrial Group Headquarters, Risley, near Warrington, Lancs (March 29).

LECTURER or ASSISTANT LECTURER IN PSYCHOLOGY—The Secretary, The University, Exeter (March 31).

SENIOR TECHNICIAN (with considerable training and experience in animal histology, and a basic knowledge of hæmatology and bacteriology)—The Secretary, Chester Beatty Research Institute, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3, quoting "Histology" (March 31).

LECTURER (with qualifications in electronics), and ASSISTANTS (with qualifications in experimental physics, theoretical physics or electronics), IN THE DEPARTMENT OF NATURAL PHILOSOPHY—The Secretary, The University, Aberdeen (April 1).

CHEMISTRY LABORATORY SUPERINTENDENT at Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 2).

MATHEMATICIAN, Scientific Officer grade (preferably with a knowledge of aerodynamics or statistics, together with an interest in physics or engineering) with the Air Ministry, for operational research duties in London—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.96/6A (April 7).

LECTURER or ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Leeds 2 (April 9).

DEMONSTRATOR (with a good honours degree in physiology or biochemistry) IN PHYSIOLOGY—The Registrar, The University, Manchester (April 10).

IMPERIAL CHEMICAL INDUSTRIES LIMITED RESEARCH FELLOWS IN BACTERIOLOGY, BIOCHEMISTRY, BIOMOLECULAR STRUCTURE, BOTANY (Plant Biochemistry and Biophysics), CHEMICAL ENGINEERING, CHEMISTRY, CHEMISTRY OF LEATHER MANUFACTURE, CHEMOTHERAPY, COLOUR CHEMISTRY AND DYEING, ENGINEERING (Civil, Electrical or Mechanical), FUEL AND REFRACTORIES, GEOLOGY (including Geochemistry), METALLURGY, MINING (Selective Flotation and Geophysical Surveying), PHARMACOLOGY, PHYSICS, PHYSIOLOGY OR TEXTILE INDUSTRIES (Chemistry of High Polymers (keratin and man-made fibres)), TEXTILE TECHNOLOGY AND WOOL TEXTILE ENGINEERING—The Registrar, The University, Leeds (April 14).

LECTURER IN PHYSICS—The Registrar, The University, Reading (April 14).

LECTURER OR ASSISTANT IN THE JOINT DEPARTMENT OF CHEMICAL TECHNOLOGY AND CHEMICAL ENGINEERING (University of Edinburgh and Heriot Watt College)—The Assistant Secretary, The University, Edinburgh (April 16).

LECTURER (with special qualifications in the chemical aspects of plant physiology, and teaching and research experience) IN BOTANY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (April 16).

ASSISTANT LECTURER IN THE DEPARTMENT OF BIOCHEMISTRY—The Registrar, The University, Liverpool (April 23).

CHAIR OF PURE MATHEMATICS tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 25).

LECTURER IN BIOCHEMISTRY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Sydney, April 30).

PROFESSOR OF EXPERIMENTAL PHYSICS at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, April 30).

CHAIRS (2) IN THE DEPARTMENT OF PATHOLOGY AND MICROBIOLOGY, University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, May 31).

AERODYNAMICISTS and AERO ENGINEERS (with a first- or second-class honours degree in physics, mathematics or engineering, or equivalent qualifications) at a Ministry of Supply Aeroplane and Armament Experimental Establishment, near Amesbury, Wilts, for duties which may include the testing of aircraft, development of test methods, interpretation of test results, and liaison with aircraft constructors—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.211/6A/AA.

AGRONOMIST (with a university degree in agriculture, and experience in field experimentation, preferably with tropical crops) in THE DEPARTMENT OF AGRICULTURE, British Guiana, to initiate and carry out crop and fertilizer trials where soil surveys are being carried out to determine optimum land use—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.79/30/01.

BIOCHEMIST (Basic grade), at the Derbyshire Children's Hospital, to work under the direction of the Group Pathologist and Principal Biochemist—The Group Secretary, No. 1 Hospital Management Committee, Babington Lane, Derby.

CHEMISTS (with experience in organic or physical chemistry), for developmental work on the preparation of isotopically labelled compounds, the separation of radioactive isotopes from irradiated materials at high levels of activity, the chemistry of natural radio-elements, and the investigation of radioactive effects in chemical compounds—The Personnel Officer, Radiochemical Centre, United Kingdom Atomic Energy Authority, Amersham, Bucks, quoting Ref. 504.

EDITOR (with a degree in metallurgy, physics or chemistry, and preferably experience in abstracting, and a knowledge of languages) OF *Metallurgical Abstracts*—The Secretary, The Institute of Metals, 4 Grosvenor Gardens, London, S.W.1.

ENGLISH ELECTRIC CO., LTD., RESEARCH FELLOW IN AERONAUTICS—The Warden, College of Aeronautics, Cranfield, Bletchley, Bucks.

LECTURER (with experience in wind tunnel research) IN THE DEPARTMENT OF AERODYNAMICS—The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks.

MASTER TO TEACH PHYSICS, if possible to advanced level—The Headmaster, Malvern College, Malvern, Worcs.

MECHANICAL ENGINEER or PHYSICIST (with a university degree or equivalent, and some knowledge of statistical techniques in research) IN THE RESEARCH DEPARTMENT, to undertake investigations into the strength of glued joints—The Director, Furniture Development Council, 11 Adelphi Terrace, London, W.C.2.

PHYSICIST, and an ENGINEER, Assistant Experimental Officer or Experimental Officer grade (with the general certificate of education, advanced level (or equivalent), in science subjects, and preferably some teaching experience), to assist with the laboratory work of the Reactor School, including constructing, maintaining and demonstrating experiments in both physics and engineering—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 511.

PHYSICIST or CHEMIST (with a first- or second-class honours degree or equivalent in physics or chemistry, and research and development experience in the field of high polymers, particularly natural and synthetic rubbers) at the Ministry of Supply Headquarters in London, for initiation and progressing of research and development work on rubbers for Service purposes and advising Service Departments on technical applications of rubber, also to maintain an up-to-date knowledge of, and close contact with, basic research and technological development at Universities and in industry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.81/6A/AA.

PHYSICIST (with a first- or second-class honours degree or equivalent in physics or chemical engineering) at a Ministry of Supply Establishment at Waltham Abbey, Essex, for research on heat transfer phenomena at very high temperatures—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.94/6A/AA.

RESEARCH ASSOCIATES IN EXPERIMENTAL AND THEORETICAL PHYSICS in the Molecular Excitation Group—Dr. R. W. Nicholls, Department of Physics, University of Western Ontario, London, Ontario, Canada.

RESEARCH ENTOMOLOGIST (preferably with an honours degree in biology and two years (three for appointment as S.S.O.) postgraduate training, or approved experience in scientific research) at the West African Institute for Trypanosomiasis Research, for duties which include some minor routine work in connexion with the running of the Entomological Section of the Institute, and primarily to undertake research upon the behaviour, breeding and longevity of the tsetse fly—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/198/04.

RESEARCH FELLOW (with a good degree in physics) IN INSTRUMENT TECHNOLOGY—The Professor of Instrument Technology, Physics Department, Imperial College, London, S.W.7.

SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (with at least the general certificate of education, advanced level (or equivalent) in science subjects, or a good knowledge, preferably to degree standard, of physics and/or chemistry, and experience in the field of particle size analysis) IN THE PARTICLE SIZE ANALYSIS SECTION of the Chemical Engineering Division's Analytical Group, to organize and supervise a section and provide a service of particle size analysis in the sub-sieve range, and to develop, or assist in the development of, new methods and instrumental techniques where required—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting Ref. 514.

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in electrical engineering or physics, and three years postgraduate experience, and preferably with some experience in any of the following fields: (1) millimicrosecond pulse techniques, (2) missile firing trials or (3) development of missile test instrumentation), to lead a team responsible for the development trials of electrical and electronic equipment for use in weapons—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 1059/34.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Papyrus Swamps of Uganda. By G. S. Carter. Pp. 25+3 plates. (Cambridge: W. Heffer and Sons, Ltd.) n.p. [181

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 948, Vol. 248 (5 January 1956): Forced Vibrations of a Rigid Circular Plate on a Semi-Infinite Elastic Space and on an Elastic Stratum. By G. N. Bycroft. Pp. 327–368. 13*s*. No. 949, Vol. 248 (5 January 1956): The Large-Scale Structure of Homogeneous Turbulence. By G. K. Batchelor and I. Proudman. Pp. 369–405. 11*s*. 6*d*. (London: Royal Society, 1956.) [181

Society for Freedom in Science. Occasional Pamphlet No. 16 (December 1955): Sir Arthur Tansley, 1871–1955. By Dr. John R. Baker. Pp. 3. (Oxford: Society for Freedom in Science, Department of Zoology, University Museum, 1955.) [181

Other Countries

The University of California Botanical Garden Expeditions to the Andes (1935–1952), with Observations on the Phytogeography of Peru. By T. H. Goodspeed and H. E. Stork. (University of California publications in Botany, Vol. 28, No. 3.) Pp. 79–142+plates 6–11. (Berkeley and Los Angeles: University of California Press, 1955.) 1.25 dollars. [181

Food and Agriculture of the United Nations. World Catalogue of Genetic Stocks—Rice. (Supplement No. 5.) Pp. vi+13. (Rome: Food and Agriculture Organization of the United Nations, 1955.) 1*s*. 3*d*. [181

Kodaikanal Observatory. Bulletin 136, Part 1: Summary of Prominence Observations for the Second Half of 1951. Pp. 46. Rs. 1/14/–; 2*s*. 9*d*. Bulletin 137: Discussion of the Results of Observations of Solar Prominences made at Kodaikanal from 1904 to 1950. By R. Anathakrishnan and P. Madhavan Nayar. Pp. 40. Rs. 5/12/–; 9*s*. Bulletin 139, Part 1: Summary of Prominence Observations for the Second Half of 1952. Pp. 46. Rs. 2/4/–; 3*s*. 9*d*. (Kodaikanal: The Observatory.) [181